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Page.

Original Articles.

The variety concept in relation to *Phalaris tuberosa* and allied forms. H. C. Trumble and A. B. Cashmore. .. .. 1— 4

Queensland grasses. C. T. White. .. .. 5— 7

Grassland problems in Kenya. D. C. Edwards. .. .. .. 8—10

Light quality and its relation to plant metabolism. M. Hall. .. 11—21

Reviews.

Pastures in the United States. 22

Controlled grazing at Valinge. [Reviewer: Miss R. Peter Jones.] 23—26

Herbage and fodder plants in South America. [Reviewer: G. M. Roseveare.] .. .. 27—34

Current Research.

Tabulated extracts from official reports. .. .. 35—57

Bibliography.

Selected bibliography on the taxonomy and agricultural botany of herbage Gramineae. 2. *Dactylis*. [Compiled by M. Hall.] .. 58—66

Soviet Research.

Selection of forage crops in the steppe part of Ukraine. I. V. Korejša. 67—69

Bacteriosis in Sudan grass in relation to selection. I. V. Korejša. .. 69—71

Drought resistance. .. .. 72—74

Research in the extreme north. .. .. 74—75

Recent Soviet publications. .. .. 76—79

Conferences.

Wageningen, Holland. .. .. 80—82

Stockholm, Sweden 82

Zürich, Switzerland. 82

Special Notice.

Second Bulletin on Vernalization. 83

THE VARIETY CONCEPT IN RELATION TO PHALARIS TUBEROSA AND ALLIED FORMS.

H. C. TRUMBLE and A. B. CASHMORE,
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(a) *Ecotypical selection in herbage plants.*

The principle of ecotypical selection, as enunciated by Turesson, and applied to herbage plants by Stapledon, has been employed with conspicuous success in the interpretation of regional strain differences and habitat response in agricultural plants. The extent to which the thesis can be applied depends on the existence of certain necessary factors, namely : (1) variability of the Linneon, (2) its capacity for regeneration from seed, (3) diversity of habitats under which its variants have been grown, (4) the time factor. The principle if followed out in its entirety must also pre-suppose a certain inflexibility or lack of adaptability of the ecotype, resulting in its elimination under conditions widely dissimilar from those under which it has been isolated.

In the case of most widely cultivated herbage plants, the above factors hold good. Hence, with perennial ryegrass, cocksfoot, red clover, white clover and lucerne in particular, a high degree of ecotypical selection has been evident. The centuries over which these plants have been cultivated and their subjection to variable environmental conditions, including many types of biota, have allowed much scope for the isolation of ecotypes. Certain of these, such as Montgomery red clover and Hawke's Bay ryegrass, have been widely sown as improved varieties, pending the production by plant breeding methods of still more satisfactory types.

(b) *Absence of ecotypical selection in Australian* Phalaris tuberosa.

In the case of *Phalaris tuberosa* we have a species the cultivation of which has received little attention until comparatively recently. The grass was practically unknown until 1904, when attention was drawn to its exceptional vigour under adverse conditions, and the area over which it has been sown can still be measured in terms of some few thousands of acres.

The probable reasons for the restricted use of this grass have already been dealt with (1). The principal reason for its importance in South Australia is its adaptability to areas of summer drought, where recognized perennial grasses and clovers of truly temperate regions have failed.

The grass as it is known in Australia was first grown from a small packet of seed at the Botanical Gardens, Toowoomba, Queensland, in 1884. With seed derived from this material, many small areas were established for trial in various parts of Australia 30 years ago and seed was also sent to foreign countries. It is probable that the majority, if not all the samples of *P. tuberosa* which have been sown intentionally, have originated from the limited number of cross-fertilizing plants grown at Toowoomba. It is of interest that the majority of the small patches established in Southern Australia are still persisting, but have not spread by natural means. Thus there are three factors limiting ecotypical selection : (1) a limited quantity of original material, (2) the time factor, of only 30 years, (3) a poor capacity for regeneration from seed on non-cultivated land, all resulting in a limited number of individuals. Furthermore, single plants of *P. tuberosa* show a wide range of adaptability to

biotic influences and to soil conditions, provided the subsoil is physically suitable. Capacity for rhizome development enables the individuals to become long-lived, and during its life a single plant may assume many different growth forms according to environment. The growth form and general development are sensitive in soil fertility, but whereas in the ryegrasses lowered soil fertility may result in death of the individuals, *Phalaris* plants are capable of holding on for long periods under adverse conditions.

(c) *Differences between Australian and foreign samples of* P. tuberosa.

In view of the above factors, it is to be expected that permanent selective influences due to environment will not readily be shown by *P. tuberosa*. In the Waite Institute collection, over 300 samples have shown little difference in growth form as between line and line whereas marked variation within the line is universal. This applies to Australian sources generally and to Californian material, which also probably originated in Australia. As distinct from these, types from Mediterranean countries show differences in vigour and fineness of leaf, but are all uniformly stemmy, erect, rather sparsely tillered, early maturing and vigorous in the first year. A type from South America tends to be robust, succulent and leafy, but many individuals of this type are to be found in the Waite collection.

Apart from these exceptions, none of which is of value for cultivation in the Adelaide environment, the bulk of the *Phalaris* cultivated to-day appears to have originated from the limited material which developed at Toowoomba from a small packet of introduced seed.

(d) *Single plant selection and strain production in* P. tuberosa.

The apparent absence of ecotypical selection among the populations of agricultural value grown at Adelaide, together with the wide variation within the individual line, has necessitated single plant selection as the basis of strain production. Vegetative persistence is a characteristic trait, and the characters in which the species is inferior to the ideal type of perennial ryegrass are—slow seedling development and susceptibility to competition in the seeding year, a tendency to stemminess, sparseness of tillering and poor seed yields. The criteria on which individual plants have been selected therefore are vigour, leafiness, density of tillering and seed production.

The selected plants have been selfed over a number of generations and judged on the performance of their selfed progeny as regards conformity to the selected type and on the vigour of their outcrossed progeny. Strain building has then proceeded by the inter-pollination in isolation of selected and tested parental types. The progeny of the massed parents are then subjected to mass selection and form the basis of a new strain.

It has still to be proved that these artificially produced strains are superior to the heterogeneous mixture of types found in commercial and collected lines. Commercial samples grown as single plants show little difference in growth form or persistency as between line and line, but certain lines have a greater proportion of desirable types than others. In sward trials there are significant differences between the yields of individual lines. The highest yields have been obtained with seed once-grown in South Australia and said to have been derived from Craw's *Phalaris*, Linton, New Zealand ; this particular line has an unusually high proportion of attractive types.

(e) *Nature of tentative strains.*

A limited number of tentative strains has been produced at the Waite Institute after four years' selection and breeding. Two of these have been selected towards two distinct types, both characterized by a high capacity for tillering and sward formation, but differing perceptibly in growth form. These strains have shown respectively 80 per cent and 90 per cent conformity to the two types for which selection was made, in the first generation after strain building. Each has been sown, to-

gether with standard commercial lines, in replicated plots which have been subjected to hard grazing in the first year. Yields under grazing will be taken in the second year (1934).

Whilst these two strains have been rigidly selected to two well defined types, several others have been built up of the best plants judged on leafiness, density and yield over a period of three seasons. These have been bulked together irrespective of growth-form but all have the common characteristics of density of tillering and high yield. These have been selected from 25,000 plants and have been found relatively homozygous in respect to leafiness and density of tillering but show obvious differences in general growth-form.

(f) *Degree of uniformity desirable.*

Should it be found necessary, a higher degree of uniformity may be obtained in future years by the use of material selfed for 4 or more generations. The authors feel, however, that in view of the limited area of *Phalaris* sown and the possibilities of expansion in the near future, it is advisable to put out tentative strains in varying habitats after four years, mass selecting from these in successive generations, and allowing opportunities for any regional selection to occur.

(g) *Variation and selection in other species of* Phalaris.

The remaining species of *Phalaris* which have been grown at the Waite Institute may be divided into (a) normally self-fertilized annuals : *P. canariensis*, *P. minor*, *P. paradoxa*, *P. angusta*, *P. Lemmoni* and *P. brachystachys*, and (b) normally cross-fertilized perennials : *P. arundinacea* and *P. coerulescens*. The annuals show great uniformity within the individual line but differences in growth-form and date of maturity are evident between lines where an appreciable number of lines has been grown.

P. coerulescens, like *P. tuberosa*, shows much variation within the individual line. Only three lines of this species have been received. It is highly self-sterile and seed production is inferior to that of *P. tuberosa*. Only the central spikelet of each cluster of five or six is bisexual, the remainder being male only. A similar condition exists in *P. paradoxa*, the associated five or six spikelets here being barren. Improvement of *P. coerulescens* is being attempted by mass selection for vigour, density of tillering and seed production.

P. arundinacea shows greater regional variation than *P. tuberosa* probably because of its wider world distribution and the longer time (approximately 200 years) over which it has been cultivated. This species also shows considerable variation within the line. The authors are grateful to Mr. T. J. Jenkin for his 4th generation hybrid material (**2**) from hand crossing between *P. arundinacea* and *P. tuberosa*. This, when grown at the Waite Institute, has given a variable mixture of types, many of which are intermediate between the two parents, but none of which resemble the standard Australian types. On the other hand, Jenkin's parental *P. tuberosa* is similar to the Australian forms. The hybrids are all too late for Adelaide conditions but some are attractive plants and might prove of value for irrigated areas or areas with a longer growing season. So far as other interspecific hybrids are concerned, the field is as yet little explored, but preliminary evidence from hybrids involving the four species *P. arundinacea*, *P. tuberosa*, *P. coerulescens* and *P. minor* indicates that there are possibilities so far as the Mediterranean type of environment is concerned.

SUMMARY.

1. The samples of *Phalaris tuberosa* grown in Australia and other parts of the world to-day apparently originated from a limited quantity of material grown at Toowoomba, Queensland, prior to 1904.

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QUEENSLAND GRASSES.*

C. T. White.

Government Botanist, Department of Agriculture, Queensland.

The known native grasses of the State, compiled from a list made by Mr. C. E. Hubbard, of the Royal Botanic Gardens, Kew, England, who spent about twelve months as botanist on the staff of the Queensland Department of Agriculture and Stock, number about 450 different kinds or species. To these must no doubt be added another fifty yet to be scientifically catalogued and described, bringing our grass flora to a total of at least 500 species. Is it not natural to assume that among these we have some of outstanding merit and worthy of every attempt to distribute and improve ?

Native Pastures.

North, Coastal and Central Queensland.

Before dealing with any grasses specifically, it is desirable to give a brief general account of our native pastures. Excellent cattle pasturage exists along much of the coastal portion of the State. Typical tropical savannah forests consisting of low eucalypts, wattles and other trees, with an undergrowth of grasses and of herbage, are found over much of the Cape York Peninsula, improving as one comes south to the Gulf country where a great mixture of grasses and herbage occurs in the pastures ; among the better grasses are Blue grass (*Dicanthium sericeum*), Kangaroo grass (*Anthistiria* sp.), Flinders grass (*Iseilema* sp.), Star grass (*Chloris* sp.), Couch grass, Love grass, *Panicum* sp., and native species of *Paspalum, Setaria* and sorghums. Southward from Ingham through Townsville to Proserpine there is a dry belt, where the native pastures are chiefly of a coarse nature. During the wet season some of the larger grasses such as the tall spear grass (*Heteropogon triticeus*), the native sorghums, etc., grow to a height of 8 - 10 feet or more. Some of the best pastures in the open eucalyptus country are composed of kangaroo grass.

Recently *Chloris barbata* has become an outstanding grass in native pastures anywhere near a settlement ; its value is rather doubtful. The common tropical weed, *Stylosanthes mucronata*, the so-called Townsville lucerne, has spread everywhere, greatly improving the pastures. This legume is very palatable to cattle and its feeding value is high. Unfortunately, it is only of annual duration and dies out on the approach of the dry winter and spring months. Among native legumes in these pastures are species of *Alysicarpus*, the most important being *A. vaginalis*. These deserve every encouragement as they at least treble the carrying capacity of the land where allowed to seed and reproduce naturally for a season or two.

From Proserpine southwards to Koumala is a district of high rainfall but poor pastures ; essentially sugar country, where stock-raising is of little importance.

Southward to about Gladstone is another dry belt. The pastures improve considerably, carrying in many cases a very heavy mixture of species, although they suffer severely from continued dry spells, particularly in the winter and spring months. In some parts of Central Queensland, native pastures are those of the coastal type, except where some of the better western grasses such as Mitchell grass (*Astrebla* sp.), Flinders grass (*Iseilema* sp.), and some of the better Panic grasses intrude. In the Burnett, Lockyer and Brisbane Valley areas, the native pastures are generally of a rather high order, but a wide area of this country has suffered severely through over-stocking and the better mixtures have been replaced by an almost pure stand of the bitter or pitted Blue grass (*Amphilophis decipiens*).

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*Reprinted in a slightly adapted form from a paper read before the Royal Society of Queensland, 23rd October, 1933. Published in *Qd. Agric. J.* 41. 54-8. 1934.

An interesting feature has been the alteration of the composition of the native pasture in certain localities, particularly near the larger towns of the south. In most cases deterioration has occurred through over-stocking, but in others the carrying capacity of the pastures has been improved by the entry of *Digitaria didactyla* and *Cynodon dactylon*.

Two distinct types of pasture in coastal Queensland are the fresh water swamp pastures of high grazing value, where the species include *Paspalum distichum*, *Panicum obseptum*, *Leersia hexandra*, *Echinochloa crus-galli* and *Hemarthria compressa*, and the salt water meadows of the whole coastal belt which in most cases consist of a pure stand of salt water couch (*Sporobolus virginicus* var. *minor*). In the more muddy places towards the edge of this pasture the couch may give way to salt water paspalum (*Paspalum vaginatum*).

Western Queensland.

These pastures are of a sufficiently high standard to be famous throughout Australia. The best known of the grass constituents are the Mitchell, Flinders, Panic, Blue, Star and Love grasses, etc. Here and there on the Darling Downs and in the Granite Belt *Danthonia* species are of some importance, although not nearly to the same extent as in the colder southern areas such as the New England Tableland. Annual herbs following the summer rains are a feature of much of this grassland.

MITCHELL GRASS.

The genus *Astrebla* is confined to Australia and its species are widespread over the heavy black soil plains of Northern and Central Australia, Queensland, and New South Wales, with the greater development in Queensland. Four distinct species are recognized :

(1) *A. pectinata*, formerly known as the Common Mitchell, is most widespread in New South Wales, but is comparatively rare in Queensland. It has a wide distribution through Central to Western Australia.

(2) *A. lappacea*, known as the wheat-eared or Curly Mitchell, is the form most abundant in Queensland. It is probably the most important species from the economic standpoint.

(3) *A. squarrosa*, the Bull Mitchell, is a coarse species not occurring in such great quantities as *A. lappacea* and of doubtful economic value.

(4) *A. elymoides* is a very distinct species and quite a good fodder grass, but suffers in comparison with its better relatives.

FLINDERS GRASS.

The pastoralists of Northern and Western Queensland regard these grasses as ranking next in importance to Mitchell grass. Four distinct species of the genus *Iseilema* are now recognized ; of these the most abundant and the best is *Iseilema actinostachys*. The value of Flinders grasses lies in their peculiar habit of growing very rapidly during the rainy season, soon dying off, but being extremely palatable and nutritious in the form of standing hay, surely a unique quality. The nutritive value is due to the amount of grain produced and the peculiar way in which it is borne among small leaves over almost the whole plant. These grasses are extremely brittle when dry, but all stock lick up the broken pieces greedily. As a hay crop for tropical and sub-tropical regions with a short rainfall season, the Flinders grasses are probably unequalled, making up in high nutritive value what they lack in bulk.

BLUE GRASS.

Dicanthium sericeum is very important on the Downs country of Queensland and New South Wales and particularly in the former State. A number of forms are distinguishable and are at present under study by Mr. C. E. Hubbard with a view to classification. Blue grass has an exceptionally high reputation as a fodder. It is

usually one of the earliest grasses to shoot after the spring and early summer rains, but is not particularly drought resistant. It makes one of the best grass hays possible and produces an abundance of seed.

PANIC GRASSES.

These grasses form a large percentage of the bulk of the average native mixed pasture. Previously they were all included under the genus *Panicum*, but this genus has now been sub-divided into smaller genera. As at present understood, twenty different *Panicum* species or Panic grasses proper, are found in Queensland.

PASPALIDIUM GRASSES.

This is one of the groups which has arisen by sub-division of the Panicums. *Paspalidium* is a small genus of about sixteen species, ten of which are found in Australia; all ten grow in Queensland although most extend also to New South Wales and the Northern Territory. Most of them are extremely palatable. *P. globoideum* produces a sago- or tapioca-like grain which is one of the staple foods of the grain-eating birds of the west. Among the smaller growing *Paspalidium* species are several known as Brigalow or Wallaby grasses. Of the Brigalow grasses proper we can now recognize at least three distinct species, but in the present state of our knowledge it is not possible to say which is the best. Probably the values are more or less similar, but in any case they represent a very fertile field for intensive work by agrostologists in the future.

GRASSLAND PROBLEMS IN KENYA.*

D. C. EDWARDS,
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GRASSLAND IMPROVEMENT.

Work has been continued on the lines indicated in the annual report for 1931, but as the more important experiments will require some years to produce reliable results, in most cases only preliminary information is available. During the year considerable difficulty has been encountered as a result of constant locust attacks. These have retarded the establishment of new experiments and have, in some cases, greatly hindered the production of reliable results from experiments in progress.

Main problems.—A consideration of the grassland of Kenya naturally falls under two heads: (1) the natural grasslands which at the moment comprise practically the whole of the land available for grazing; and (2) the cultivated grasslands which are only just beginning to be of importance. The former are utilized mainly by the stock-owning native tribes, but even in the areas of European settlement pasture management has, as yet, progressed little. Cultivated pastures under comparatively intensive management have already made their appearance in European areas of higher rainfall where the dairying industry is growing and these pastures are likely to become of ever-increasing importance in such areas. In the former case the main requirement is the development of improved management which will prevent deterioration of the valuable grasslands concerned. Unfortunately, advanced stages of deterioration have already been reached in certain native reserves where overstocking has become serious. In connexion with the development of small areas of cultivated pasture, it is necessary to determine the herbage species best suited for the purpose in various districts which experience different climatic and soil conditions.

As a basis for the whole of this work a study of the individual herbage species has been undertaken. Attention is devoted mainly to the indigenous species as it is believed that it will be possible to isolate plants which will fulfil the requirements of the country better than introduced species. A considerable number of introduced plants has, however, been included in the experiments.

Natural pastures.—The improved management of large tracts of natural pasture in Kenya depends mainly on: (1) limitation of stock to the carrying capacity of the areas concerned, and (2) the possibility of introducing a system of controlled grazing by means of which local over-grazing will be prevented and regular periods of rest for different areas in turn will be provided. The problem has assumed a serious aspect in some areas, as for instance, the Ukamba Native Reserve, where a continually increasing stock population together with deforestation of the higher land has resulted in the partial destruction of the herbage cover over considerable areas with consequent erosion and in a reduced period of river flow. The difficulty of applying measures under the above heads which will bring about improvement in native areas is evident. Amongst stock-owning tribes wealth is considered in terms of cattle and the marriage customs are based upon the payment of the bride-price in cattle and goats. Under these circumstances it is not surprising that the native cannot be induced to part with stock to an extent that will materially affect the overstocking problem. In addition to these facts the application of methods of disease control has aggravated the position by preventing, in some measure, the reduction in stock normally caused by disease. The introduction of control of grazing is also beset with difficulties in native areas under present conditions, although it is believed that it is not beyond the bounds of possibility. In European ranching the application of methods of controlled grazing should be comparatively simple. The main factors on which the application of improved methods in native grazing

*Reprinted from Kenya Colony and Protectorate Dept. Agric. Annual Report, 1932. Nairobi, 1933.

areas depend are (*a*) the distribution of water supplies and (*b*) the ownership of land. Unless adequate distribution of permanent water supplies can be provided it is obvious that proper distribution of stock and the prevention of local over-grazing cannot be accomplished. Where any form of private ownership either by individuals or groups exists it may be possible to introduce control of a nature which will permit the closing of areas bounded by geographical features in rotation, to allow for periods of rest. In this way an attempt may be made to apply the principles of deferred rotational grazing which have been used with success in the U.S.A. for the reclamation of vast areas of over-grazed range lands.

Cultivated pastures.—Up to the present, cultivated pastures have played very little part in the stock industry of Kenya, but, as has already been stated, they are likely to become of increasing importance in areas of European settlement. In the native reserves, although the development in this direction will obviously be much slower, it is believed that in the thickly populated areas of comparatively high rainfall, such as parts of the Kikuyu Reserve, more intensive methods of farming will become increasingly necessary, and that cultivated pastures will play a part in future development. In connexion with more intensive methods of stock farming under European agriculture, two types of cultivated pastures have to be taken into account. One of these comprises areas where a suitable type of herbage already exists, such as in high rainfall districts where Kikuyu grass (*Pennisetum clandestinum*) is dominant. Here the development of cultivated pastures entails merely fencing and the application of intensive methods of grazing and manuring. The other type consists of areas where suitable pastures will have to be artificially established by the propagation of species superior for the required purpose to the natural herbage, or where it is desired to lay down land, originally under arable farming, to grass. So far the former type of pasture is the only one that has made its appearance. In the high altitudes many attempts have been made to establish European species and seeds mixtures, but these have not yet proved of any appreciable importance.

WORK IN PROGRESS.

Experiments designed to provide information on the effects of different intensities of grazing and also of grass-burning on natural pasture have been continued at two centres where the dominant type in the herbage is *Themeda triandra* (red oat grass) while similar experiments to test the effects of different intensities of grazing have been set up in Kikuyu grass (*Pennisetum clandestinum*) and star grass (*Cynodon plectostachyum*) areas. In the last two areas mentioned, the grazing schemes had to be discontinued for the greater part of the year because of locust attack which so damaged the herbage that no reliable results could be expected.

In connexion with these experiments observations are being made on the seeding habits of the main grasses with a view to utilizing the information in the application of schemes of light rotational grazing such as the deferred method devised in America, which has already been mentioned. There is, however, considerable variation in the seasons from one to another and it will therefore be necessary to obtain information in each area where it is proposed to attempt to apply this method.

With the object of determining the most valuable pasture plants and so learning something of the relative value of different types of natural grazing, and at the same time collecting information on those plants best suited for the establishment of cultivated pastures, a study of the individual pasture species has been continued at the Scott Agricultural Laboratories at Nairobi. During the year work was commenced on an experiment intended to provide data on the seasonal yields of herbage and nutrients of a number of grass species which had been selected as the result of palatability tests and from other properties which became evident in the course of these investigations. The lack of suitable land for the purpose and constant locust attack have greatly retarded this work. When the choice has been sufficiently narrowed down it is proposed to conduct trials under actual grazing conditions.

In connexion with the establishment of pastures in European farming areas methods of propagation of the pasture species are important. Although certain stoloniferous grasses can be established from roots and pieces of the runners fairly cheaply, in most cases establishment from seed is the only practicable method. With this fact in view a study of the seeding qualities of the promising pasture species has been continued. As has been previously reported, in the case of the indigenous grasses results have, on the whole, been disappointing. Certain species have given satisfactory results in preliminary work, however, and several grasses have been added to this number during the year. Considerable difficulty has been encountered in obtaining sufficient seed for experimental work in the first instance, and early in the year seed production plots were established. In common with other experiments these suffered severely from locust attack and the initial establishment was in most cases either prevented or greatly retarded.

Preliminary results from the several phases of the work indicate that the most promising indigenous species are as follows: *Pennisetum clandestinum* (Kikuyu grass), *Cynodon plectostachyum* (star grass), *Chloris gayana* (Rhodes grass), *Panicum coloratum*, *Pennisetum ciliare*, *Amphilophis pertusa* and *Paspalum scrobiculatum*.

The only introduced grass which has given decidedly promising results as yet is *Paspalum dilatatum*, while a strain of *Chloris gayana* from Australia has also given good preliminary results. This latter was originally introduced to Australia from Africa.

The matter of the suitability of species to areas of different climatic conditions in the country is very important. In the above list, for instance, Kikuyu grass and *Paspalum scrobiculatum* are each suited only to limited areas. On this account efforts have been made to establish observational plots of the more important species in various parts of the country.

Fodder plants.—This name is used here to indicate plants which are suitable for cutting and feeding green to stock or for the making of ensilage. The importance of a supply of green fodder and hay for use in periods of droughts is becoming more generally recognized in the European stock-farming of the country and work is in hand to compare both indigenous and introduced plants for this purpose. One of the most promising plants is Elephant or Napier grass (*Pennisetum purpureum*) which is indigenous in Kenya. Another indigenous grass (smaller than *P. purpureum*, but attaining a height of about six feet) which has recently received attention and which shows considerable promise is another *Pennisetum* sp. (nr. *P. polystachyon*).

LIGHT QUALITY AND ITS RELATION TO PLANT METABOLISM.

M. Hall.

The effect of light quality on plant growth is being studied at various agricultural centres and in view of possible interest in the developments of this line of enquiry a bibliography of works relating to the subject has been compiled.

The part played by light in plant growth may be considered from the following aspects :

(1) Ecological, involving the study of soil types associated with the chemical composition of plants. Since herbage is selective in absorbing ions it is necessary to consider the quality of radiant energy required for the optimum utilization of various nutrient ions.

(2) Physiological, involving the study of phototropisms and of nutrition.

(3) Biochemical, involving the study of vitamins and pigments.

(4) Pathological, involving consideration of reaction of disease organisms to specific wave-lengths.

Literature on the subject from these aspects is very extensive and it was considered that a brief review of those works which bear more directly on points which concern the agriculturist would be useful.

The nature of radiation.

Light is an electro-magnetic phenomenon and is measured by an estimation of one or other of the different forms (actinic or thermal) into which it is converted (Braid, 1923). The Ångstrom unit of light wave-length$=1 \times 10^{-10}$ metre, but wave-lengths are often expressed in millionths of a millimetre ($\mu\mu$). Thus measurement of the D Fraunhofer line can be recorded as follows : $\lambda=0.589616\mu$, or $589.616\mu\mu$, or 5896.16 Å. U. (Baly 1927).

The following table is extracted from Cooper (1930).

Colour of light.	Wave-length in Ångstrom units.
Infra-red	30,000—7500
Red	7500—6500
Orange	6500—5900
Yellow	5900—5750
Green	5750—4900
Blue	4900—4550
Violet	4550—3950
Ultra-violet	3950—2900

Radiation and photosynthesis.

In their paper " Photosynthesis and the electronic theory," Dixon and Poole (1920) consider the question how, in photosynthesis, the raw materials carbon dioxide and oxygen are rendered reactive by chlorophyll when exposed to light. They maintain that the process is in some way connected with the behaviour of negative electrons and attribute the conversion of light energy into chemical energy to the intervention of electrons displaced by light. The authors' experiments show that those wave-lengths of light which are effective in photosynthesis are unable to expel electrons from the leaf pigment complex and therefore neither ionization nor reactions external to the pigment, can be produced in this way. The association of the four

pigments chlorophyll *a*, chlorophyll *b*, xanthophyll and carotin in constant proportions in chloroplasts and the chemical relationships of these substances "suggest a transference of electrons between the components of the pigment complex in the chloroplast securing the ultimate reduction of the carbon dioxide and the liberation of oxygen. This transference must be effected directly or indirectly by light." Dixon and Ball (1920) record that light, where λ=615 $\mu\mu$—725 $\mu\mu$, is absorbed by chlorophyll and as electrons are not expelled the energy is wholly or partially used in their displacement within the chlorophyll molecule, by which some atomic group or groups are made reactive.

Maximum efficiency in photosynthesis depends on the number of quanta of energy absorbed per molecule of carbon dioxide reduced. The relation between this number and the wave-lengths of incident energy is recorded by Briggs (1930). The work of Senn (1908) is quoted in which it is shown that the shape, size and position of chloroplasts depend on various factors, one of which is the spectral composition of the illumination.

In experiments with *Phaseolus*, Ursprung (1918) shows that there is decrease in efficiency per incident energy in passing from the red to the blue end of the spectrum. Briggs' experiments on the same plant confirm this. James (1934) considers photsynthesis as a heterogeneous photochemical reaction which obeys Einstein's law of equivalence, i.e. each molecule of the photoreactant absorbs only one quantum of light energy. In accordance with the quantum theory photochemical reaction diminishes with wave-length (Warburg and Negelein, 1923). Baly (1928) records that in order to synthesize one gram molecule of glucose or fructose, a minimum quantity of energy equal to 673,800 calories must be supplied to the carbonic acid. The energy directly absorbed in the leaf from the red end of the spectrum of wave-length 660 $\mu\mu$ is only 260,000 calories and it is contended that sufficient energy is not absorbed directly from sunlight for this synthesis. It is shown by Scarth (1932) that light affects stomatal movement by means of that portion of its spectrum which is absorbed by chlorophyll. Sayre (1929) has shown that stomata do not open in light of wave-length longer than 690 $\mu\mu$ and it is suggested that red light beyond this length only affects plants by its conversion to heat energy.

Radiation in agricultural problems.

The work of Laurens (1928) is concerned solely with light in relation to therapeutics, but a brief account is given of solar radiation in different regions of the earth which may interest ecologists. On entering the earth's atmosphere 5 per cent of the total solar radiation (1.93 gram calories per sq. cm. per min.) is ultra-violet, 52 per cent in the visible region of the spectrum and 43 per cent in the infra-red. In penetrating the atmosphere there is a certain amount of extinction and absorption so that at the earth's surface and at average heights of the sun with a total radiation intensity of 1.0 gram calorie per sq. cm., the distribution is ultra-violet 1 per cent, visible 40 per cent, and infra-red 59 per cent. The total intensity depends on height above sea level and on seasonal variations. At a height of 1800 metres only 75 per cent of the total solar radiation penetrates and at sea level this amount is reduced to 50 per cent. Spring sunlight is strongest and richest in infra-red, and by comparison the autumn sun is richest in ultra-violet. It is shown by Knipping, 1924 (*Arch. Schiffs.- u. Tropenhyg.* 28, 269) that radiation intensity per unit of time in many tropical places differs very little from that of temperate regions in clear summer weather. Tropical towns of the British and Dutch Indies in low lying coastal areas with high humidity and much dust do not receive as great intensity of radiation as areas on the North Sea coast in June. The region of the Red Sea in Arabia which has few clouds and low humidity also receives low intensity, primarily because of dust. Crowther and Ruston (1911-12) found that in an industrial area 40 per cent of the light registered is cut off by suspension matter in the air. The method used by these workers is not necessarily applicable for study

of the less refrangible rays of the spectrum. Evidence has been obtained which shows that coefficients of absorption for red and violet light respectively of two soot suspensions were a little higher for red than for violet.

The question of light in relation to plant growth has been investigated at the Boyce Thompson Research Institute. Popp (1926) conducted experiments on a variety of plants including among others Sudan grass, soybeans and sunflowers. Observations were made on the effect of varying conditions of light quality on flowering, vegetative vigour and fruiting. The following is extracted from the author's summary.

" 1. When plants were grown in daylight from which all wave-lengths shorter than 529 $\mu\mu$ were eliminated, they developed the following characteristics as compared with plants grown in the entire spectrum of daylight.

(a) An increased rate of elongation of the stem of all species during the first two or three weeks' growth ; a greater final height in soybeans (which adopted the twining habit), but a decided decrease in height in sunflowers and Sudan grass.
(b) A considerable decrease in thickness of stems.
(c) A reduction in the number of branches or side shoots.
(d) A general curling or rolling of the leaves.
(e) Good development of chlorophyll but a reduction in anthocyanin of leaves and flowers.
(f) Less differentiation of stem and leaf tissues ; less compact and thinner-walled cells, and a reduction in strengthening tissues.
(g) Considerable delay in time of flowering and a reduction in the number of flowers produced.
(h) Very weak development of seeds, fruits and general storage organs.
(i) Decrease in fresh weight and dry weight and an increase in percentage of moisture.
(j) Considerable decrease in starch and total carbohydrates, and generally an increase in total nitrogen : often an increase in soluble nitrogen compounds.

The degree to which these different effects were produced varied with different species but all had an etiolated appearance apart from abundance of chlorophyll.

2. When all wave-lengths shorter than 472 $\mu\mu$ were removed the same effects were produced as listed above but to a lesser degree.

3. When only ultra-violet rays were eliminated none of the foregoing results were obtained.....although there was a small increase in length of stems.....compared with plants receiving these rays.....Sudan grass and sunflowers bloomed earlier than they did under other conditions.

The results obtained with plants, from which all wave-lengths shorter than 529 $\mu\mu$ or 427 $\mu\mu$ were eliminated, are similar to those obtained when plants are grown under greatly reduced light intensity." In these experiments it is shown that light intensity is not an important factor, and that while ultra-violet rays are not indispensable, the blue-violet end of the spectrum is necessary for normal vigorous growth.

Pfeiffer (1928) shows that plants grown under the red and blue portions of the spectrum result in poor anatomical development compared with those grown under other portions of the visible spectrum. Téodoresco (1929) maintains that the most refrangible rays restrict growth in length while the red-yellow end causes elongation as in etiolation. Shirley (1929) studied the effect on vegetation of light under a forest canopy. The quality of light is changed in passing through a leafy canopy through partial absorption of red and blue rays. The author found that the entire visible and ultra-violet solar spectrum is more efficient for plant growth than any separate portion of it, and the blue region is more efficient than the red. It is also concluded that the

quality of forest light is not a seriously limitating factor for herbage in such associations. Shaw (1908) records that light at high altitudes is considerably more intense than on adjacent lowlands and this difference is chiefly in the most refrangible rays. Under experimental conditions additional blue-violet light to ordinary daylight caused a structural response in plants. Leaves were more pubescent and internodes shorter. The author concludes that light at high altitudes has probably a definite morphogenic value, differing from that at low altitudes.

It has been shown that ultra-violet light has an effect on the development of red (anthocyanin) pigment in plants and that the red-orange region of the spectrum is most important for assimilation of carbon dioxide. Blue rays influence growth rate. The close relationship which exists between leaf area and light intensity is studied at the Cheshunt Experimental Station, Herts. Increase in leaf area, due to light intensity, gives greater efficiency in food production. See Blackman (1934).

The influence of environmental factors on pasture flora is recorded by Cooper, Wilson and Barron (1929). Pentavalent elements undergo a change of valence due to the action of radiant energy. Thus sunlight would appear to effect a change of valence bonds which accompanies photosynthesis. The above authors conclude, from an examination of soil under pasture, that there is no very close correlation between the pH of soil and the type of herbage it supports. They maintain on the other hand that the quantity and quality of the cations in the soil complex are more valuable in determining the suitability of an area for specific plants. In their paper a list of the standard electrical potentials of some common nutrient materials is given because it is contended that electrical properties of materials constitute the best grouping for giving a general idea of their qualities. Energy is considered as being compounded of two factors—the capacity factor and the intensity factor. A quantity of electricity expressed in coulombs is a capacity factor and electrical pressure expressed in volts is an intensity factor. Those interested in absorption and nutritional studies are concerned particularly with relative electrical pressures, i.e., the intensity with which electrical energy tends to become active. Differences in electrical potential are an indication of the chemical affinity between reacting substances. Elements which have a relatively low standard electrical potential are specially sensitive to radiant energy. The reactions between specific elements and their sensitivity to certain wave-lengths are recorded and it is considered that the nutritional requirement of various species of plants may be related to their capacity to absorb different quanta of radiant energy. An earlier paper by Cooper and Wilson (1927) deals with a correlation between electromotive series and oxidation potentials in some pasture plants. Cooper (1930) records that light affects the intake by plants of certain nutrient ions. Vegetation which requires a fertile soil, or strong ions, is not tolerant of shade and has a high feeding value. Each wave-length in the visible spectrum is correlated with a definite energy value which is said to be effective in plant nutrition in the following ways: (1) by decomposing nutrient compounds; (2) by causing a change of valence; (3) by activating certain molecules, atoms or ions. In the work of Sheard and Johnson (1930) it is stated that since physical and chemical changes in cells necessitate an absorption of energy and since protoplasm absorbs energy of short wave-length in addition to certain infra-red radiations, it was considered that an investigation of chemical changes produced in leaves under selected radiation would yield information on the nature of the specific physical or chemical processes. *Helianthus* was used in the experiments and data show that changes in electromotive forces in the leaves are produced by infra-red and ultra-violet radiations. There is evidence that there is an increase in ions in the leaf stimulated by these rays and there may be a change in permeability of the membranes. It is also concluded that growth is induced in part by changes in electromotive force and is thus indirectly dependent on specific radiant energy. Sheard and Higgins (1927) state that diffuse daylight inhibits seed germination and root growth and since in interior daylight there is a preponderance of rays of greater wave-length and an absence of ultra-violet

radiation, then inhibition in germination is due to rays of long wave-length. The authors' experiments support the hypothesis that the normal function of an organism or its growth, when kept in an unphysiologic environment, is stimulated by rays in the ultra-violet region. It is also contended that these rays stimulate endogenous growth as a whole while radiations of greater wave-length in the visible spectrum influence exogenous metabolic processes. Similar results are recorded by Higgins and Sheard (1927) in experiments with cucumber seed, i.e. wave-lengths of 320 $\mu\mu$—390 $\mu\mu$ are particularly effective in inducing growth. Sayre (1928) found that wave-lengths longer than 680 $\mu\mu$ are not effective in chlorophyll formation of wheat oats, barley, beans or sunflowers. Effectiveness of radiant energy increases from 300 $\mu\mu$ in the ultra-violet to 680 $\mu\mu$ when it ends abruptly.

Chlorophyll deficiencies.

The work of Henrici (1926) draws attention to the relation between photosynthesis and chlorophyll content of leaves. Daily fluctuations in the chlorophyll content of South African grasses were found to be influenced by the amount of moisture present in the atmosphere. Ireland and Yeats (1933) discovered chlorophyll deficiency in sorghums after four seasons of self-fertilization. A positive correlation was found between chlorophyll content and yield. Studies were undertaken on soil temperature, light intensity and evaporation in relation to chlorophyll deficiency. It was established that chlorophyll content increases generally to the time of seed maturity, begins to decrease as the grain hardens and varies directly with evaporation and temperature. In determining relative concentrations of chlorophyll in the sorghum leaves, use of the microspectroscope is said to be the most satisfactory method.

Lubimenko (1928) emphasizes the value of pigmentation in genetical work. Pigments have strong absorption bands and since absorption of light is in direct proportion to the number of molecules of absorbed material, concentration of a solution C, can be obtained from the formula

$C_1 = C_0 \frac{h_0}{h_1}$ in which C_0 is the concentration of a standard solution, h_0 is its density and h_1 is the density of the analysed solution at the point where light absorption of both spectra is the same. Apparatus and methods are described in detail. Absorption lines of chlorophyll are in the region of λ=670 $\mu\mu$ —650 $\mu\mu$ and those of protochlorophyll in λ=640 $\mu\mu$— 620 $\mu\mu$. Xanthophyll and carotin must be separated from chlorophyll for determination, the best method of separation being precipitation with barium hydroxide, which with chlorophyll forms an insoluble compound in alcohol. Subsequent processes in this separation are given. In certain inheritance studies it is shown that chlorophyll quantity in normal green lines is a dominant character. In F_1 hybrids pigment quantity is found to be a mean between that of the parents. F_2, F_3 and F_4 generations, however, show a complicated inheritance of this feature and further research is necessary.

In the following bibliography there are included references to works on phototropisms and to those of a biochemical nature in which forage crops are used in the experiments. With few exceptions works which deal specifically with ultra-violet radiation and its effects are excluded. Spectrographic methods are employed in cases where light quality is studied and by this type of analysis fractional distribution of elements can be tested. For instance Ramage (1929) maintains that rubidium is shown by this method to be widely distributed in soils and plants. The growing points of cereals in contrast to their other parts, are shown to be more rich in rubidium than potassium.

For the application of this type of analysis the firm of A. Hilger Ltd., 98, King's Road, Camden Road, London, N.W. supplies all apparatus necessary in addition to tuition in manipulation of the instruments.

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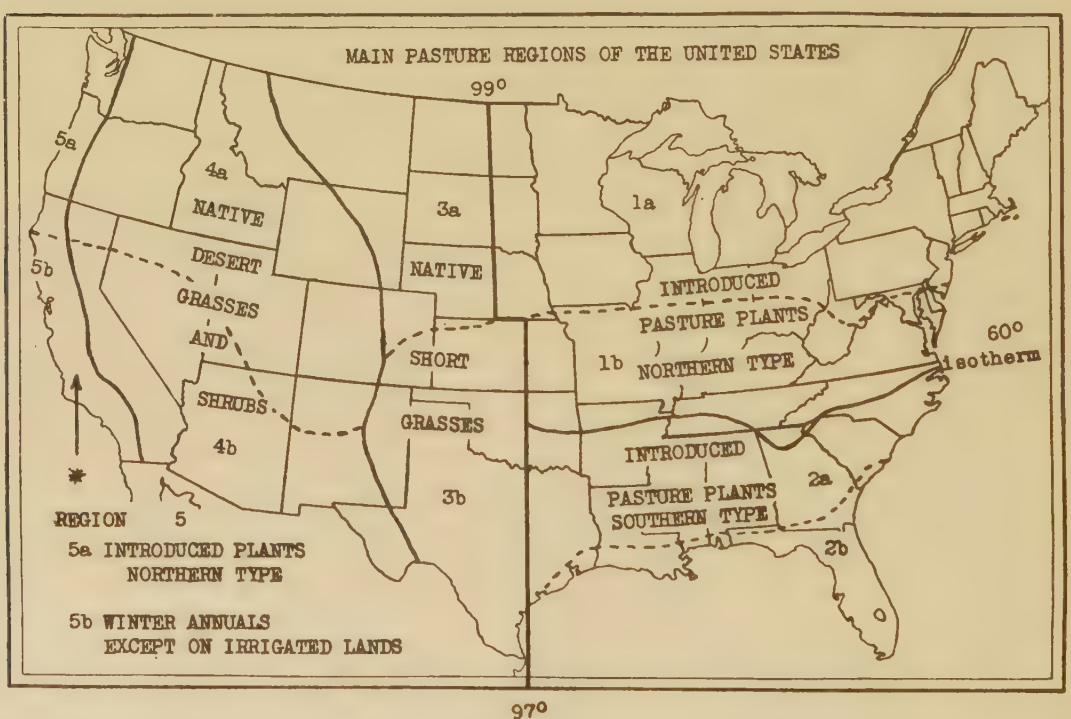
REVIEWS

PASTURES IN THE UNITED STATES.

The United States Department of Agriculture is producing shortly a pasture handbook. This has been preceded by two mimeographed circulars, one on " Pasture plants and pasture mixtures adapted to different parts of the United States " by H. N. Vinall, Senior Agronomist, Division of Forage Crops and Diseases, the other on " Grasses and legumes for permanent pastures," by H. N. Vinall and C. R. Enlow. The map here reproduced from these circulars indicates the main pasture regions of the United States.



The kinds of grasses and legumes which provide most of the pasturage in the United States vary with both soil and climatic conditions. The five natural pasture regions as determined by the climate are indicated in solid lines on the map, and each of these regions is subdivided by dotted lines into sections a and b, chiefly because of their temperature relations. On the Pacific Slope, however, the dotted line separates the more or less humid northern section from the drier southern part. Further details will be found in the circulars mentioned, and in the pasture handbook when available.

CONTROLLED GRAZING AT VALINGE.*

[*Reviewer*: Miss R. PETER JONES.]

The Valinge estate is situated in the province of Södermanland, Sweden. By the courtesy and with the co-operation of the owner, Mr. N. R. Kleen, extensive controlled grazing was initiated there in 1915 by the Live Stock Department of the Swedish Central Institute of Agricultural Research and is still in progress.

The estate comprises, in addition to the manor of Valinge itself, three outlying farms, Kärrsjö, Olstorp and Hagersta. The total area of arable land is 285 hectares. There are in addition extensive wooded pastures which are also used for grazing.

The object of the controlled grazing carried out at Valinge from 1915-1931 was to throw light on the development of pasture production on the estate and to show what factors have exerted most influence thereon. Further, an endeavour has been made to ascertain the capacity of the different kinds of animals to utilize the pasture grass and to investigate the possibilities of preserving the surplus pasture for winter foddering.

The annual number of controlled grazing animals amounted during the first control years to approximately 220, but during the last five years it has risen to an average figure of 270. Of these 55 were calves less than 12 months old, 73 younger and older heifers, 9 young bulls, 111 milch cows and 22 horses. The considerable addition to the stock has entailed a very great increase in milk production during the grazing period. In addition the rearing of young cattle has been conducted on such a scale that in recent years quite a large number of heifers and young bulls have been sold as breeding cattle.

The evaluation of the fodder value of the grazing days has been based on the age, average weight, increase in weight and milk production of the different groups of animals, the fat content of the milk produced also having been taken into account. The norms employed for evaluation have been those fixed by the Grassland Section of " Nordisk Jordbrugsforskning " (Scandinavian Agricultural Research). They are based on the assumption that in pasture foddering the same number of food units is required for the animals' maintenance and production as was shown to be necessary during winter foddering. Consequently the pasture has in each case been evaluated in accordance with the norms which have been worked out on the basis of experience from stall feeding and of foddering trials conducted during such stall feeding.

The most important results obtained with controlled grazing at Valinge recorded in the present paper may be summarized as follows:

The pasture production of the farm which in 1915 amounted to 105,000 food units had in 1931 risen to 258,000 food units, thus by not less than 144 per cent. This increase had been made possible partly by extension of the cultivated leys on older arable land from 40.2 to 66.4 hectares, partly by improved management and manuring of both cultivated leys and wooded pastures.

Improvement of the cultivated leys has in the first place consisted in a more thorough ditching to the full depth of drainage, more liberal manuring with artificial fertilizers, but above all with solid and liquid farmyard manure, together with more careful grazing of the pasture fields divided into not less than 44 different folds. By these measures it has been possible to increase the maximum yield per hectare of good cultivated leys from 3,000 food units during the first control years to more than

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*HANSSON, Nils, and HAGMAN, David. Några resultat från beteskontrollen å Valinge under åren 1915-1931. I. Betets produktion och tillgodogörande. [Some results of controlled grazing at Valinge during the period 1915-1931. I. Production and utilization of pasture.] *K. Landtbr. Akad. Handl. och Tidskr.* 71. 369-435. [German summary, 429-34.] Stockholm, 1932.

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4,000 food units per hectare in 1931. In the last mentioned year the pasture complex Storängen, which comprises 16.4 hectares, yielded in its entirety 3,974 food units per hectare and 4 of its 7 folds produced on an average 4,300 food units per hectare.

Cultivation of the wooded pastures has chiefly consisted in complete clearing by removing all overshadowing trees on the pasture areas proper, careful draining, and liberal manuring year by year. After necessary ground liming a special application of phosphoric acid and farmyard manure has had a good effect. By these measures the yield of the best wooded pastures during the control years has been increased by as much as 100 and 200 per cent, and in many cases it has been possible to use wooded pastures as grazing places even for such exacting grazing animals as heavy milking cows.

The utilization of the pasture is encouraged in part, as already stated, by its division into a large number of folds, in the grazing of which the most exacting grazing animals, heavy milking cows, calves and younger heifers, always precede the less exacting, such as low milkers, dry cows and older heifers. Further, the winter foddering of young cattle above the age of 12 to 18 months has been diminished so that the increase during the six winter months has been reduced by as much as 100 to 150 grm. per animal a day, as that was seen to entail so much the greater growth on the pasture.

During the last control years the herbage was so plentiful during the height of the summer that it was possible to utilize the surplus for winter foddering. In 1929 and 1930 the surplus amounted respectively to 15 and 17 per cent of the whole production of the pasture, but in 1931 it rose to 29 per cent. The surplus was used partly for hay curing, partly for ensilage.

The pasture stand intended for hay curing was cut when the plant stand was 25-30 cm. high. The plant mass was dried on the ground for 36 to 48 hours and afterwards hung on double drying-hurdles. The " hay of pasture type " obtained in this way was found to have a high fodder-value with 6.7 — 6.9 per cent digestible protein and 53-58 food units per 100 kg. Thus 1.75 - 1.9 kg. of the hay can be considered equivalent to 1 food unit.

For ensilage the pasture grass was cut when the stand had attained a height of 15-25 cm. By this means a more rapid aftergrowth was obtained than after cutting for hay curing. Ensilage of the pasture grass is also much less dependent on weather conditions than is hay curing.

Experience gained at Valinge indicates that cutting of the pasture grass for hay curing should not be repeated on the same ley more frequently than every other year, otherwise the composition of the pasture stand is influenced in an unfavourable direction. The earlier cut for ensilage can on the other hand without disadvantage be taken every year, particularly when the rainfall is abundant, which is usually the case during years when the herbage on pastures is plentiful.

As has been pointed out previously, pasture grass can be produced considerably more cheaply per food unit than all other home-grown fodders. This is confirmed in full by the results obtained at Valinge, where an extended and carefully conducted pasture management is to be regarded as one of the chief means of reducing the cost of animal production.

The investigations carried out in connection with controlled grazing at Valinge regarding the growth, composition and digestibility of the pasture stand have *inter alia* given the following results :

The growth of the pasture stand under the conditions prevailing in Central Sweden is greatest during the first summer months, so that more than 70 per cent of the annual growth takes place in May, June and July. As early as the end of August growth decreases considerably, and this decrease is still more marked during September and October. At Valinge on the average only 2 to 3 per cent of the annual growth occurred after 22nd September.

The trials designed to ascertain the annual yield of the pasture leys by means of fixed sample plots set out on them, and which were cut at approximately the same

time as the remaining area was grazed, have not given entirely satisfactory results. Under normal conditions these sample plots have given on the average a 13-15 per cent higher yield than when the yield of the pasture has been evaluated on the basis of the average weight, increase and yield of the grazing animals.

It has been shown that the botanical composition of the pasture stand is determined to a marked extent by the time of year, the manuring of the soil and the utilization of the pasture in addition to the nature and drainage of the soil, the original flora and the seed used for sowing. As a rule the percentage of clover determined in dried samples at Valinge has been lowest during the spring months, has reached its maximum during July and August, and fallen again in the autumn. During the first control years the percentage of clover in the best pasture folds rose to a maximum of 25 to 30 per cent while in 1931 the corresponding figures were 30 to 37 per cent.

Manuring of the pasture folds has been seen to have a distinct influence on the composition of the pasture stand. In particular, manuring with phosphoric acid—following liming, where this was necessary—has increased the clover content of the stand, while a liberal application of nitrogen appears to have had a contrary effect. Repeated heavy manuring of the cultivated leys with carefully distributed farmyard manure and liquid manure has, however, not prevented their percentage of clover rising to the above-mentioned values.

With regard to the utilization of the pastures it has been clearly established that continued cutting and clipping entails dislocations in the botanical composition of the sward. Cutting in a late stage of development favours the growth of tall grasses at the expense of low growing grasses, while the contrary occurs with repeated clipping. In both cases the percentage of clover in the stand is reduced.

The chemical composition of the meadow and pasture plants changes considerably during growth. The dry content rises throughout, likewise the content of nitrogen-free extractives and above all of fibre, while the content of crude protein, pure protein, digestible protein and minerals, also the digestibility of the nutrient substances fall continuously. Thus it follows that cutting in the pasture stage gives the most nutritious and in every respect the most valuable fodder.

The clover species have throughout the lowest content of dry matter but the highest content of nitrogenous substances. The grasses have a higher content of dry matter and of carbohydrates and have, therefore, from the dietetic point of view a more favourable effect than clover alone or in preponderance.

The chemical composition of the pasture stand has for the rest shown itself to be dependent on the nature of the soil and manuring, also on variations in the botanical composition of the stand and in weather conditions during the year. Poor wooded pasture-land gives a less nutritious plant stand than well tended cultivated leys, but with careful draining and manuring there is no difference in this respect. As one-sided manuring with lime and phosphoric acid favours the growth of clover at the expense of the grasses, the fodder obtained with this manuring is richer in protein than that obtained when one-sided manuring with nitrogenous fertilizers has been carried out. The chemical composition of the stand from completely manured leys has throughout been better than that of the stand from unmanured leys.

The dry matter content of the pasture in addition to being dependent on the botanical composition of the stand is especially affected by rainfall conditions duringe and immediately preceeding cutting In the investigations now reported the dry matter content has varied between 18.0 and 30.0 per cent, and under normal weather conditions and on the average might be estimated to be about 22 per cent.

The dry matter in normal pasture grass from Valinge has been found to contain 17.3 per cent crude protein, 3.6 per cent crude fat, 45.2 per cent nitrogen-free extractives, 24.6 per cent fibre and 9.3 per cent ash. In a stand of grass alone the crude protein content falls to approximately 16 per cent, in a stand of white clover only it rises to approximately 25.5 per cent. The former corresponds to a content

of 100-110 grams, the latter to approximately 200 grams of digestible protein per food unit. With a clover content of 15 to 20 per cent in the pasture stand the protein requirement even of heavy milking cows would appear to be met ; with 25-30 per cent clover there is as a rule a small excess of protein, but when the clover content in dried samples was above 40 to 50 per cent this excess became so significant that it gave rise to digestive disturbances.

During growth the chemical composition of the pasture stand varies in the same way as that of the stand on hay leys. The pasture has, therefore, the highest nutritive value and the greatest utility in an early stage of development.

The digestibility of the pasture grass is very high. Of its organic matter as much as 80 per cent is utilized, and on the average of 12 digestibility trials with dried pasture grass the following coefficients of digestibility were obtained : crude protein 78, crude fat 62, nitrogen-free extractives 79 and fibre 81.

According to the investigations conducted it can be calculated that 1.10 - 1.15 kg. dry matter in pasture grass corresponds to 1 food unit. Of such grass with a dry matter content of 22 per cent, 5 kg. therefore constitute one food unit. Owing to the considerable variations in moisture content of pasture grass, one must, however, reckon with fluctuations between 4 and 6 kg. One food unit of normal pasture grass contains 125-150 grams of digestible protein. The high fodder value of pasture grass is for the rest dependent on its large content of completely combined mineral substances and on the plentiful occurrence of vitamin A in particular.

HERBAGE AND FODDER PLANTS IN SOUTH AMERICA.

Reviewer: G. M. ROSEVEARE.

General.

South America has very considerable possibilities as a continent in which search might be made for new species and varieties of herbage and fodder plants. The most striking results obtained from plant collections in this part of the world are those obtained on behalf of the Institute of Plant Industry, Leningrad, by Bukasov, whose work on the Andean potatoes has provided much information of the greatest value (*Imp. Bur. Plant Genet.*: *Herbage Plants*. Bull. No. 13. pp. 10-1. 1933). Possibly similar rewards are in store for collectors of herbage and forage plants. More particularly, it is quite possible that South America holds the key to the problem of the pasture legume for arid lands in the tropics and elsewhere.

It is only attempted here to indicate some of the sources whence information may be obtained. In view of the number of references in the bibliography and lack of space in this issue of *Herbage Reviews*, the review section of this article must necessarily be brief. Further details can be had from reference to the papers themselves or will be supplied by the Bureau. Information as to papers which have been omitted, together with reprints, if available, will be sincerely welcomed, and should be addressed to the Imperial Bureau of Plant Genetics: Herbage Plants, Aberystwyth, Wales. A supplementary bibliography will be published in due course.

In a recent geographical survey of the flora of temperate South America by Good (*Ann. Bot.* 1933), it is noted that Gramineae and Leguminosae are very strongly represented in the temperate regions. Early literature on the subject of South American grasses and legumes is necessarily sparse, and generally forms part of flora or of ecological studies. More recently the work of Parodi, Reichert, Hauman, Grieder, Hitchcock, Berger, Burkart, Cross and others has shed a considerable amount of light upon the botanical and agricultural properties of South American herbage plants.

Work on general grassland improvement which merits attention is that of Professor Boerger at La Estanzuela, Uruguay; as do the articles by G. E. Spangenberg in *Rev. Fac. Agron. Montevideo*, 1930, and by Parodi on the pampas of the Province of Buenos Aires in 1930.

Gramineae.

The work of Professor Lorenzo R. Parodi in Argentina is of particular interest. In 1923, Professor F. Reichert, with the collaboration of Parodi, R. A. Trelles and I. P. Grünberg, produced in book form, for the University of Buenos Aires, the first contribution to a study of the indigenous and cultivated forage plants of the Argentine Republic, comprising botanical descriptions and chemical analyses of fifty-six species, mostly Gramineae. The second contribution appears in the *Rev. Fac. Agron.*, published by the University of Buenos Aires, in 1926. Parodi has further published in the same journal revisions of a number of Argentine and South American grasses (*Diplachne*, *Sporobolus*, *Alopecurus*), a study of the grasses of the Concordia district (1922) and in 1930 a very complete phyto-geographical treatise on the pampas prairie in the north of the Province of Buenos Aires. A series of notes by Parodi on Argentine grasses have appeared in Physis, a periodical published by the Argentine Natural History Society, Buenos Aires. This journal also published Hauman and Parodi's notes on the grasses of southern South America, based largely upon studies in the herbaria of Brussels, Kew and Paris.

A. S. Hitchcock has presented a study of the grasses of British Guiana in *Contr. U.S. Nat. Herb.* 22. Pt. 6. 1922, pp. 83, and of those of Ecuador, Peru and Bolivia in *Contr. U.S. Nat. Herb.* 24. Pt. 8. 1927, pp. 262.

Brazilian grasses are dealt with by Doell and Hackel in Vol. 2 of Martius and Eichler's " Flora brasiliensis " (1871-72 and 1878-83). Bertoni has reviewed more than 100 species and varieties in the littoral forest region of the upper Parana (Paraguay, Brazil and Argentina) ; and in 1926 Agnes Chase spent six months in eastern Brazil, and collected and described from 500 to 600 species. Uruguayan grasses were studied by Archevaleta in 1894-97, and have been reviewed more recently in Osten and Herter's " Plantae uruguayensis," 1929. A study of the South American species of *Festuca* (sub-genus *Eu-Festuca*) has been made by Saint-Yves in *Candollea*, 1927.

Lucerne.

The importance of lucerne growing in South America can hardly be overrated.

Earlier reports in English on lucerne cultivation in Argentina may be found in *J. Bd. Agric.* 2. 13-14, 1895 ; 10, 40-1, in an article by H. Gibson on Argentina's agricultural progress, 1903 ; in *J. R. Agric. Soc.*, Ser. 3. 6. 675-84, article by H. Gibson, 1895 ; and in *N. Z. J. Agric.* 22, 217-20, 1921, where official information from the Division of Agricultural Investigations, Buenos Aires, is published. Cultivation of lucerne hay in Chile is described in *J. Bd. Agric.* 2. 70. 1895 ; and the history of lucerne growing in southern South America discussed by Boerger in the *Tropenpflanzer* (Berlin) of 1926 is abstracted in *Biol. Abst.* 2. 613. Entry 6629. 1928.

More recently a review of lucerne cultivation in all parts of the globe has been published by M. Klinkowski in Bull. No. 12 of the Imperial Bureau of Plant Genetics : Herbage Plants, 1933 ; the present position in the various South American countries is dealt with on pp. 36-41.

Professor Boerger's book " Observaciones sobre agricultura," 1928, a treatise on fifteen years' phytotechnical work in Uruguay, contains an interesting chapter on lucerne, pp. 221-61.

A study of the effect of selfing and cross-fertilization upon seed-setting in Buenos Aires lucerne has been published by Burkart and Ragonese in *Rev. Cent. Estud. Agron. B. Aires*, 1933. Heavier seed yield was obtained from cross-fertilization. The article includes interesting records of the insects observed to have visited the plants, and of those which are effective in producing fertilization.

Legumes.

Increased attention has been paid of late to the importance of legumes other than lucerne. In this connection the following recently published articles are of interest : Grieder, in the *Tropenpflanzer*, 1933, enumerates a number of native South American legumes which are worthy of improvement and cultivation ; Memmler, in *An. Soc. Rur. Argentina*, 1932, lists a number of legumes suitable for cultivation in various parts of the Argentine Republic, according to climatic and soil conditions ; and Parodi in *Gaea*, 1932, presents a study of plants observed in an outlying region of northeast Argentina, many of which, almost unknown to the rest of the country, have been used as crop plants since the days of the Incas. Species of *Phaseolus* and a plant which is probably *Pachyrhizus* are included. In the *Rev. Fac. Agron. B. Aires*, Vol. 6. 1929, Burkart gives a valuable summary of the cultivated and adventitious Papilionatae of the Argentine Republic, classified according to their seed structure ; and he reviews legumes of the La Plata district in *Physis*. Vol. 9. 1928-29. *Phaseolus* has been studied by Hassler (*Candollea*, 1922-24), who reviews the South American species ; and by Ivanov, who sowed out at Sukhum over 1,000 samples collected in South America by Bukasov and Juzepczuk, and notes that the greatest varietal diversity in *Phaseolus* is to be found in South America (*Proc. U.S.S.R. Cong. Genet., Leningrad*, 1929).

Diseases, pests, etc.

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CURRENT RESEARCH

TABULATED EXTRACTS FROM OFFICIAL REPORTS.

The material collected in this section was formerly published as Miscellaneous Notes in *Herbage Abstracts*. In this new form, based upon that adopted in a recent Australian publication (see *Herb. Publ. Ser.* Bull. 14), it is possible by using the subject index to acquire knowledge on a wide range of research problems which are being studied in all parts of the world. The review is not necessarily complete, as it refers only to reports received since 1st November, 1933.

Readers interested in research according to the country in which it is in progress should refer immediately to the main part of this section of *Reviews*, where the countries are dealt with in the order of the decimal classification, proceeding from Europe to Asia, Africa, America and Australasia in that order.

Readers requiring knowledge as to stations and departments investigating a particular problem should turn to the subject index, where they will find references to all the research items Nos. 1-75, tabulated under the subject of the problem.

This new section of *Herbage Reviews* represents part of a Bureau's activity as a clearing house of up-to-date information, with a view to the elimination of duplication in research and the reduction of the time lag between research and the published paper, not to mention the abstract. It is hoped that all investigators concerned with grassland and forage problems will make full use of the material provided, and that for further information they will apply direct to the station or department concerned or to the Chief Officer of this Bureau.

Subject Index.

Subject of Research.	Research Items. Numbers and letters refer to subdivisions of geographical sections, commencing on page 38, (Nos. 1-4).
HCN content.	63(d), 64(b), 65(c), 73(a).
Protein.	43(a), 51(a).
Cystine.	70(a).
Nodule bacteria.	60(a), 60(b), 72(m).
Physiology (*Metabolism*)	40(d), 41(c).
(*Germination and growth*)	18(a), 32(c), 61(a), 63(c), 66(d), 72(n).
(*Pollination*)	55(b), 55(c).
(*Dehiscence*)	41(a), 42(d).
Chemical composition.	5(a), 5(b), 7(b), 18(d), 20(a), 20(b), 21(d), (21e), 21(g), 24, 36, 40(a), 40(b), 40(c), 53(a), 53(d), 64(b), 65(a), 65(b), 65(c), 65(d), 71, 72(b), 72(e), 73(b), 74(a).
Anatomy and Morphology.	1(a), 72(o).
Ecology.	40(c), 57(d).

Toxicity. 40(d), 53(b), 62(b), 69, 70(c), 73(a), 74(d).

Floras and Systematics. (*Botanical analyses*) 1(a), 10(a), 10(b), 16(d), 18(b), 18(c), 20(f), 21(e), 37(c), 45(f), 62(a), 72(b), 72(o).

Soils. 6(c), 16(a), 18(h), 53(d), 64(a), 65(b).

Soil (seed) inoculation. 12, 18(i), 25, 59(e).

Selection (*Seeds mixtures*). 6(b), 11(d), 15(b), 18(f), 26(a), 45(g), 49(c), 58(c).

Plant selection (*Resistant varieties*). 3(a), 11(b), 15(e), 26(c), 39(b), 41(f), 45(h), 47(a), 47(b), 51(e), 55(a), 61(b), 66(b), 66(c), 72(f), 72(g).

Seed testing. 8, 14(b), 54, 59(b), 59(d), 63(a), 74(c).

Plant breeding. 15(a), 38(b), 39(d), 41(a), 41(e), 41(g), 45(a), 45(b), 45(c), 45(d), 45(e), 45(i).

Seed production (*Sowing*). 11(a), 15(c), 15(d), 20(d), 20(e), 21(a), 26(e), 27(b), 28(b), 38(a), 39(d), 45(b), 56(a-i), 57(a), 58(c), 59(f), 66(d), 66(e), 72(k), 74(b).

Harvesting. 18(g), 20(b), 31(a), 34(g), 40(f), 43(a), 43(c), 50(f), 52(a), 57(f), 58(a), 64(a), 66(f).

Yields. 3(b), 3(d), 14(a), 16(b), 23(a), 23(b), 24, 26(a), 26(b), 27(b), 31(a), 51(d), 52(a), 58(a), 65(d), 72(b).

Fodder conservation. 27(c), 32(e), 34(e), 42(c), 63(b).

Management. 1(b), 3(c), 5(b), 6(a), 9, 11(d), 15(f), 17(a), 27(a), 32(a), 32(b), 37(d), 37(e), 37(f), 39(a), 41(b), 41(c), 42(a), 42(b), 43(d), 44(a), 45(a), 45(f), 46, 50(a), 50(d), 72(c), 72(d), 72(h), 72(i).

Fertilizers. 3(b), 7(a), 16(a), 16(c), 16(d), 16(e), 18(e), 19, 20(a), 20(c), 21(a), 21(b), 21(c), 21(d), 21(e), 21(f), 27(d), 31(a), 44(b), 49(b), 58(a), 58(b), 59(a), 59(c), 65(b), 65(d), 70(b), 72(a), 72(b), 72(e).

Diseases, weeds and pests. 4(b), 10(b), 13(a), 13(b), 18(h), 21(f), 47(a), 48, 53(b), 57(b), 61(c), 67, 68(a), 68(b), 68(c), 69, 70(c).

Herbicides. 1(c), 18(a).

Forage crops. 9, 11(a), 11(b), 11(c), 15(a), 15(e), 26(d), 32(d), 32(e), 33, 34(f), 34(g), 42(a), 45(d), 45(i), 70(a), 72(f), 72(o), 73(b), 74(a).

Grasses. 1(a), 1(b), 18(d), 24, 26(d), 27(a), 31(a), 31(b), 32(b), 32(c), 38(a), 38(b), 38(c), 39(b), 52(d), 52(e), 53(c), 56(a-g), 62(a), 66(b), 66(c), 72(k).

Grassland, meadows and pastures. 3(d), 4(a), 5(b), 6(a), 6(c), 7(a), 10(a), 16(d), 17(a), 17(b), 18(c), 19, 20(c), 20(f), 21(b), 21(g), 23(b), 24, 29, 31(b), 32(a), 35, 36, 37(a), 37(d), 37(f), 37(h), 38(c), 39(a), 39(c), 40(b), 40(e), 42(a), 42(b), 44(a), 44(b), 45(a), 46, 49(a), 50(d), 50(e), 51(c), 52(b), 53(a), 57(b), 57(c), 57(d), 58(a), 64(a), 65(a), 65(b), 65(c), 65(d), 66(a), 70(b), 71, 72(a-i), 73(b), 74(a).

Grass genera.

Poa	51(a), 51(b).
Dactylis	15(d), 21(a), 56(c).
Agrostis	56(e), 65(b).
Phleum	47(a).
Cynodon	32(b), 34(g).
Lolium	20(e), 56(a), 56(b), 59(b), 59(d), 61(a), 61(b), 63(a), 63(c), 65(b).
Paspalum.	56(f), 63(e).
Phalaris	60(e), 66(f).
Tripsacum	52(a).
Andropogoneae.	15(g), 22, 26(a), 26(b), 32(b), 37(b), 43(c), 66(d), 73(a), 74(d).
Pennisetum	26(d), 32(b), 52(a).
Panicum	31(a), 52(a).
Melinis	52(a), 75(a).
Digitaria	39(b), 39(c), 39(d).
Trichopteryx	37(b).
Holcus	56(d).
Danthonia	65(b), 66(e).
Chloris	75(c).
Spartina	52(d), 52(e).
Gynerium	53(c).
Agropyron	56(g).
Arundinaria	50(c).

Legumes (*General*). 12, 34(d), 37(g), 43(a), 43(d), 56(i), 72(m).

Legume genera.

Medicago.	14(a), 15(c), 17(b), 18(i), 28(c), 34(a), 41(b), 41(d), 41(e), 45(b), 45(h), 50(b), 55(a), 55(b), 55(c), 60(a), 75(b).
Trifolium.	3(a), 14(b), 16(e), 17(b), 18(i), 20(d), 21(a), 26(e), 28(c), 45(c), 45(h), 47(b), 50(b), 56(h), 61(c), 63(d), 64(b).
Vigna.	26(b), 31(c), 34(a), 43(a).
Glycine.	15(f), 41(a), 42(d), 43(a), 45(e), 50(b), 51(e).
Vicia.	18(i), 28(b), 50(b).
Arachis.	34(a), 34(b).
Mucuna.	26(c), 43(a).
Lespedeza.	45(i), 50(e), 50(f).
Melilotus.	45(h), 48.
Lupinus.	34(a).
Crotalaria.	50(b).
Ornithopus.	18(i).
Alysicarpus.	52(b), 52(c).
Pisum.	50(b).
Phaseolus.	27(b), 34(a).

Fodders. 34(c), 34(f), 40(a), 40(f), 40(g), 41(f), 43(b), 72(p).

Lawns. 57(e).

Grazing. 2, 3(c), 4(a), 5(a), 5(b), 20(c), 23(a), 23(b), 28(a), 30, 32(b), 37(b), 37(e), 40(f), 41(d), 45(f), 50(c), 51(b), 52(c), 57(f), 58(a), 58(d), 59(a), 59(b), 72(j).

Palatability. 22, 34(b), 34(c), 34(d), 34(g), 37(h), 40(e), 40(g).

RESEARCH TABULATED IN GEOGRAPHICAL ORDER.

	Page
Scotland, England, Austria, Norway, Sweden, Holland, Switzerland.	38 - 43
India, Palestine, Straits Settlements and Federated Malay States.	43 - 46
Kenya, Tanganyika Territory, South Africa, Southern Rhodesia.	46 - 49
Canada, U.S.A., British Guiana, New Zealand, Australia, Fiji.	49 - 57

SCOTLAND. (41.25)

Publication: Report on Work of North of Scotland College of Agriculture. Year 1932-1933. Aberdeen.

RESEARCH: 1. (a) Identification of British grasses in non-flowering state by means of cross-sections of leaf. Method has proved easy and reliable.

(b) Study of response to domestication of native grasses.

(c) Weed eradication by chlorates. Results published in two papers.

INVESTIGATOR: D. Clouston, Lecturer in Agricultural Botany.

LOCATION: North of Scotland College and Craibstone Experimental Farm.

RESULTS: Paper on item (a) to be published.

RESEARCH: 2. The extent to which stomach worm (*Haemonchus contortus* and *Ostertagia circumcinta*) infestation of lambs can be reduced by a system of progressive sectional grazing.

INVESTIGATORS: D. Robertson and A. H. H. Fraser.

COLLABORATION: North of Scotland College and Rowett Research Institute.

RESULTS: A reduction in infestation of 99.2 per cent was obtained. See *J. Helminthology*, Vol. II. No. 4.

RESEARCH: 3. (a) Comparison of strains of *Trifolium pratense* and *T. repens*;

(b) effect of sulphate of ammonia on early grass or milk yield;

(c) live-weight increase from rotational as compared with continuous grazing;

(d) live-weight increase from two five-year-old pastures.

INVESTIGATOR: Wm. M. Findlay, Superintendent of Experiments.

LOCATION: Craibstone Experimental Farm.

RESULTS: (a) Broad-leaved reds poorer than late-flowering; of these Montgomery and Cornish Marl were best. White clover poor owing to heavy hay crop in previous year, combined with dry summer.

(b) 3 cwt. sulphate of ammonia applied to five-year-ley rich in white clover did not produce earlier grass or more milk.

(c) No greater live-weight increase obtained from rotational method.

(d) Danish cocksfoot earlier in spring, well eaten; white clover developed well, helping the cocksfoot; New Zealand cocksfoot grew later and quicker, cattle unable to eat it off, eared badly and adversely affected the white clover.

Publication: Twentieth Report of West of Scotland Agricultural College, Glasgow, 1933.

RESEARCH: 4. (a) Value of succulent pasture to dairy cows;

(b) taints in milk flavour due to pasture weeds, etc.

INVESTIGATORS: Andrew C. McCandlish and Prof. R. H. Leitch.
RESULTS: See *Herb. Abst.* 4. 72. 1934.

RESEARCH: **5.** (a) Hoven or bloat in dairy cattle.;
(b) suitable pasture management to prevent bloat.
INVESTIGATORS: Andrew C. McCandlish and D. G. O'Brien.
RESULTS: See *Herb. Abst.* 4. 54. 1934.

Publication: Report of Edinburgh and East of Scotland College of Agriculture for year ending 30th September, 1933.

RESEARCH: **6.** (a) Improvement of some types of vegetation of hill pastures which have not hitherto responded to manurial treatment, by mechanical treatment, manuring and sowing.
(b) Seeds mixture trials for field trial of new products of the Scottish Plant Breeding Station, Corstorphine.
(c) Pasture surveys in Berwickshire, to study relation of soil conditions to a rapid rate of deterioration.
INVESTIGATORS: E. Wyllie Fenton and J. A. MacDonald, Edinburgh.
R. G. Heddle, Edinburgh.
Dr. W. G. Ogg, Macaulay Institute for Soil Research, Aberdeen.
COLLABORATION: Edinburgh and East of Scotland College and Macaulay Institute for Soil Research [Items (a) and (c)].
RESULTS: Paper on item (a)—see Heddle and Ogg, *Herb. Abst.* 4. 53. 1934.

RESEARCH: **7.** (a) Effect of nitrogenous manuring on composition of pasture;
(b) chemical composition of heather (*Calluna vulgaris*).
INVESTIGATORS: Dr. A. Lauder, J. M'Gillivray and Dr. A. Comrie.
RESULTS: Reports on four-years' work on item (a) to be published.

Publication: Report of Seed Testing and Plant Registration Station for Scotland. Edinburgh, 1929-32.

RESEARCH: **8.** Routine work of seed testing, including field trials.
RESULTS: Data are presented as regards purity and germination tests of many herbage plants; also behaviour of certain herbage plants in field trials to confirm source of origin and type.

ENGLAND. (42)

Publication: Reports on work of Agricultural Research Institutes in the United Kingdom. 1931-2.

RESEARCH: **9.** All research on herbage plants and forage crops included.
INVESTIGATORS: See list of directors of Research Institutes, etc., pp. 380-3, and names of individual investigators under the different research items described.
RESULTS: Titles of papers issued during the year under review are appended to the various reports.

Publication: Journal of South-Eastern Agricultural College, Wye, Kent, No. 33. January, 1934.

RESEARCH: **10.** (a) Botanical analysis of pastures on Romney Marsh.
(b) Compilation of list of host plants attacked by dodder.

INVESTIGATORS: S. T. Parkinson, R. T. Pearl and R. M. Harrison.

RESULTS: Estimations made under item (a) of the proportionate area covered by tillers of different species of plants in a six-inch square have shown that herbage varies according to particular soil series, both in manner of growth and percentage and variation of species.

Publication: Report of Rothamsted Experimental Station for 1932.

RESEARCH: **11.** (a) Trials with fodder crops.
(b) Production of hardy fodder crops during autumn, winter and following spring.
(c) Value of grass and other fodder crops.
(d) Clovers and fodder mixtures in rotations.

INVESTIGATORS: See Report for staff.

RESULTS: (a) Applications of N favour oats and depress vetch; total N content of crop not appreciably altered; experience with kale as fodder crop very promising.
(b) Ryegrass best for autumn growth; addition of beans and vetches improved yield further.
(c) Attempts are being made to overcome the difficulties of expressing the value of herbage to the animal by new experimental methods based on principles of replication and randomization, thereby allowing a valid estimate to be made of error.

RESEARCH: **12.** Inoculation of legumes.

INVESTIGATOR: Dr. H. G. Thornton.

COLLABORATION: Rothamsted Experimental Station and Welsh Plant Breeding Station, Aberystwyth.

RESULTS: Studies being extended to clovers; tests being made in Welsh hill experiments. Search for more efficient strain of lucerne organism continues; certain cultures kept for period without apparent change have suddenly broken up into new forms. Attention being given to problem why nitrate of soda which benefits non-legumes should adversely affect nodule formation in leguminous roots.

RESEARCH: **13.** (a) Observations on insect pests.
(b) Observations on fungous diseases.

INVESTIGATORS: (a) H. C. F. Newton.
(b) Mary D. Glynne.

RESULTS: (a) *Dasyneura leguminicola* present on flower heads of clover [See Metcalfe, *Herb. Abst.* 3. 92. 1933].
(b) *Claviceps purpurea* found on ripened plants of *Dactylis glomerata*, *Lolium* and others.

Epichloe typhina found chiefly on *Agrostis*, but also on *Dactylis glomerata*. Eye estimations showed that liming decreased and ammonium sulphate increased the disease. How far this effect depends upon the distribution of *Agrostis* is doubtful.

Other diseases noted were *Peronospora Trifoliorum*, *Sclerotinia Trifoliorum* and *Pseudopeziza Trifolii*.

Publication : Fourteenth Report and Accounts (1932-33) of National Institute of Agricultural Botany, Cambridge.

RESEARCH : **14.** (a) Yield and quality trials and observation plots of lucerne (Provence, English, Grimm, Hungarian and Marlborough).

(b) Testing of *Trifolium repens* in connection with certification scheme.

INVESTIGATORS : For staff see Report.

COLLABORATION : Active contact under item (b) with Wild White Clover Growing-on Committee.

AUSTRIA. (43.6)

Publication : Activities of Federal Institute for Crop Production and Seed Testing (Der Bundesanstalt für Pflanzenbau und Samenprüfung), Vienna, in 1932.

SOURCE : Article by H. Kallbrunner, Pflanzenbau 10. 123-6. 1933.

RESEARCH : **15.** (a) Breeding of clovers and grasses.

(b) Trials with seeds mixtures.

(c) Method of sowing lucerne.

(d) Value of pure cultures of *Dactylis glomerata*.

(e) Study of suitable winter forage crops.

(f) Value of soybeans as green fodder, grown alone, with barley, or with oats.

(g) Observations on Sudan grass (*Andropogon sorghum* var. *sudanense*).

RESULTS : (a) The breeding of 13 mountain grasses at stations 800-1300 m. above sea level was continued, the seed obtained being sown at a height of 1900 m. with excellent results.

(b) Superiority indicated of simple mixtures and of those red clover-grass mixtures with larger proportion of grasses. A seeding rate showing a reduction of 25 per cent on that recommended by Weinzierl and Stehler (48 kg. per ha.) is considered preferable.

(c) In dry regions similar yields are obtained from broadcast or drill sowings ; yield is higher in pure cultures than in lucerne-grass mixtures.

(d) Poor yields obtained in dry regions in spite of good development.

(e) *Vicia pannonica* superior to *V. villosa*. Early sowing of winter mixtures necessary, Rye (80 kg.) with field peas (70 kg.) and *Vicia pannonica* (60 kg.) was found to give better yield than wheat in winter mixtures.

(f) Trials of 28 varieties in 40 localities been in progress since 1924. Cultivation now extended to 2,000 ha. Late varieties are used for fodder ; acclimatized strains have proved quite winter-hardy.

(g) Results obtained are moderate. The crop generally proved palatable to animals ; yield superior to *Panicum italicum* var. *germanicum* and inferior to maize. Mixtures with various legumes were tested.

NORWAY. (48.1)

Publication : Report of Norwegian Bog Cultivation Society's Experiment Station (Norske Myrselskaps Forsoksstasjon) at Maeresmyra, 1931 and 1932.

RESEARCH : **16.** (a) Different rates of distribution of N-fertilizers on boggy land (grass bog, depth ¾-1 m., lime content 300-400 kg. per maal = 1000 sq. m. ; reaction of pH = 5).

(b) Increase in yield of hay per maal.

(c) After-effect of various N-fertilizers.

(d) Botanical composition of meadows after different N-fertilizers.

(e) Percentage of clover in meadows after N-applications.

INVESTIGATOR : Hans Hagerup.

SWEDEN. (48.5)

Publication : Report on work at the Ultuna Institute of Agriculture, School of Agriculture and Farm (Lantbruksinstitut, Lantbruksskola och Egendom) in 1932.

RESEARCH : **17.** (a) The use of grass leys in experimental rotations.
(b) Comparison between lucerne and red clover for 3 to 4 year leys.

INVESTIGATOR : Dr. G. Giöbel and assistants.

RESULTS : (a) Very good yields given by all the leys, particularly the first year leys.
(b) The effect of lucerne on the succeeding crops was not found to be markedly greater than that of red clover in the years in question.

HOLLAND. (49.2)

Publication : Report of the State Agricultural Experiment Station for Crop Production and Grassland Farming (Rijkslandbouwproefstation voor den Akker- en Weidebouw) at Groningen. 1933.

RESEARCH : **18.** (a) Influence of sodium chloride on plant growth.
(b) Technique of botanical analysis.
(c) Observations on botanical composition of different swards.
(d) Chemical composition of grass.
(e) Manurial problems.
(f) Seeds mixtures.
(g) Time and method of cutting.
(h) Weed control in relation to soil acidity.
(i) Preparation of bacterial cultures for inoculation of lucerne, clover, seradella (*Ornithopus*) and vetch.

INVESTIGATORS : Prof. O. de Vries and assistants.

RESULTS : (a) Concentrations of more than 1 grm. per litre of medium (water cultures) produce an inhibitive effect on both germination and growth.

(b) Methods being tested include the collection of a sample from a number of different places in a sward, the sorting out of component species blade by blade, later either determining the weight of air-dried grass or counting the blades per species ; also the quadrat system on pastures and young hay meadows. A study is made of the number of samples necessary for obtaining an accurate estimate of an area. Samples should not exceed 1-1.5 kg.

(c) Data have been obtained concerning influence of different factors on botanical composition, and the characteristics of various types of grassland ; also a comparison has been made between a newly reclaimed polder and nearby old grassland with a view to forming seeds mixtures ; a special study has been made of gradual changes in the vegetation of certain saline lands.

(d) Data have been obtained on composition of fourteen important grasses at three different places (loamy sand, fen land and clay), and also of mixed stands.

RESEARCH : **19.** Fertilizer trials on grassland.

INVESTIGATOR : Prof. O. de Vries and assistants.

RESULTS : See *Herb. Abst.* 4. No. 2. 1934, under Holland, 631.8-1.421 (49.2).

Publication: Report of Government experiment fields in Utrecht and south-east Noordholland, 1931 and 1932.

SOURCE: Mimeographed issue, pp. 59, tables. [German summary, 4 pp.] by C. K. van Daalen.

RESEARCH: **20.** (a) Effect of various fertilizers (N in particular) on chemical composition of hay.

(b) Effect of rainfall on lime and phosphorus content of hay.

(c) Trial of N-fertilizers on rotationally-grazed pastures.

(d) Comparative trial of strains of *Trifolium repens* (Kentish wild white, Morsø and a commercial variety).

(e) Comparative trials of *Lolium perenne* strains.

(f) Botanical composition in 1932 of grassland sown in 1926.

INVESTIGATOR: Dr. C. K. van Daalen.

COLLABORATION: Local farmers and the State Nitrogen Works.

RESULTS: (b) Results confirm Woodman's findings.

(c) Continuation of previously reported work (see C. K. van Daalen, *Herb. Abst.* 2. 144-5. 1932); present results of economic nature chiefly.

(d) Kentish first, Morsø second.

(e) Kentish first, commercial second.

(f) *Poa trivialis* and *Trifolium repens* developed as well where not sown as where sown. Not necessary to include them in seeds mixtures.

SWITZERLAND. (49.4)

Publication: Report on work of Agricultural Chemistry Institute at Liebefeld, Berne, for 1932.

SOURCE: Article by E. Truninger, *Landw. Jahrb. Schweiz.* 47. 1094-1119. 1933.

RESEARCH: **21.** (a) Pot trials on effect on *Trifolium pratense* and *Dactylis glomerata* of applications of nitro-phosphate and liquid manure at different times (3 weeks before sowing, time of sowing, 3 weeks after sowing).

(b) Use of liquid manure on meadowland.

(c) Trials of three commercial phosphates.

(d) Effect of various forms of lime dressings on lime content of herbage.

(e) Study of respective consequences of one-sided and balanced manuring upon botanical and chemical composition of the sward.

(f) Efficiency of fertilizers in suppressing *Galium mollugo*.

(g) Chemical composition of grass.

RESULTS: (a) Diminished yield in *T. pratense* from application 3 weeks before sowing; in *Dactylis glomerata* from topdressing 3 weeks after sowing.

(b) Five-fold dilution of liquid manure produced increase of 48 per cent in first year, 5 per cent in second year and nil in third year,

(f) Heavy manuring with calcium nitrate most effective.

(g) Two-thirds of the land in question is wholly or partly deficient in phosphorus; about one-half requires an annual dressing of potash.

INDIA. (54)

Publication: Reports on working of Department of Agriculture of Central Provinces for years ending 31st March, 1932, and 31st March, 1933, Nagpur.

RESEARCH: **22.** Nutritive value of two types of herbage (a normal local pasture with dominance of *Andropogon humulis*, and an area seeded with better strains of grasses such as *Ischaemum sulcatum* and *I. laxum*).

INVESTIGATOR: Director of Agriculture and assistants.

LOCATION : Telinkheri farm.

RESULTS : Yield of dry grass per acre 50 per cent greater from the seeded area. Proportion of minerals in local pasture somewhat high, although the actual amount of CaO and P_2O_5 removed from the soil will be similar in both areas.

RESEARCH : **23**. (a) Yield of forest grazing areas.

(b) Influence of opening and closing to grazing on total quantity of grass produced.

COLLABORATION : Department of Agriculture and Forestry Department.

Publication : Report of Agricultural Chemist, Central Provinces, for year ending 31st March, 1933.

RESEARCH : **24**. Yield and chemical analysis of grasses from permanent pasture plots (connected with Research item 22).

INVESTIGATOR : D. V. Bal, Officiating Agricultural Chemist to Government, Central Provinces.

RESULTS : As stated in item 22, with additional data. Monthly cuts of local grass plots produced higher yield than cutting once at flowering or dead-ripe stage. This difference was not noted in the improved grass mixture (see item 22). A high percentage of silica in improved mixture indicates that the increased intake of silica has to a certain extent helped to remove the P_2O_5 deficiency, and that the phosphorus absorbed by the plants was utilized very efficiently.

RESEARCH : **25**. Isolation of nodule organism for treating leguminous seeds.

INVESTIGATOR : D. V. Bal and Deputy Director of Agriculture, Northern Circle.

RESULTS : Sufficient for treating 800 lb. of seed distributed.

Publication : Report on operations of Department of Agriculture, Punjab, for year ending 30th June, 1933. Part I. Lahore, 1934.

RESEARCH : **26**. (a) Yield of Sudan grass, alone and in mixtures.

(b) Testing of cowpeas (*Vigna*) and Imphee jowar (*Andropogon sorghum*) for yield of green fodder ; multiplication of a superior selection of cowpea.

(c) Trial of a promising selection of velvet bean (*Mucuna*).

(d) Tests of various fodders, including elephant grass (*Pennisetum purpureum*).

(e) Production of a pure seed nucleus of *Trifolium alexandrinum* for multiplication on the various seed farms.

(f) French oats as fodders.

INVESTIGATOR : Director of Agriculture and staff.

RESULTS : (a) Results entirely satisfactory ; crop will occupy a large percentage of the area under other non-leguminous fodder crops when sufficient seed is available.

(b) Drought resistant qualities of cowpeas indicated, superior in this respect to Sudan grass, Imphee jowar or maize.

(d) Elephant grass is becoming very popular as a fodder.

(e) Berseem is very popular ; further work is considered to be unnecessary.

Publication : Report on operations of Department of Agriculture, Madras Presidency for year 1932-33.

RESEARCH : **27.** (a) Comparative trial of local indigenous grasses under irrigation in small plots.

(b) Yield studies and distribution of seed of pillepesara (*Phaseolus trilobus*).

(c) Various fodders as silage.

(d) Manurial experiments (application of farmyard manure).

INVESTIGATOR : Director of Agriculture and staff.

COLLABORATION : Department of Agriculture and Livestock Research Station, Hosur [item (d)].

RESULTS : (a) Best grasses were *Andropogon annulatus, Pennisetum cenchroides* and *Iseilema laxum*. Teosinte yielded 32,000 lb. green fodder per acre at one centre (Coimbatore).

(b) *Phaseolus trilobus* gave 22,600 lb. green fodder per acre in two cuttings. Very popular among peasant cultivators.

(c) Silage good, giving succulent fodder for cattle during hot months, March and April.

(d) An experiment to test the effect of applications at rate of 10 and 20 cart-loads per acre every year and in alternate years indicated advantage of applying at rate of 10 cart loads.

PALESTINE. (56.9)

Publication : Report of Department of Agriculture and Forests for years 1931 and 1932. Jerusalem, 1933.

PROBLEM : **28.** (a) General observations on quality and quantity of grazing.

(b) Encouragement of growing of vetch-oat mixture.

(c) Cultivation of *Trifolium alexandrinum* and lucerne.

INVESTIGATOR : A. F. Nathan, Assistant Director of Agriculture and Forests.

OBSERVATIONS : (a) Grazing poor throughout country ; frequently consisted of crops which had not matured and were not worth harvesting. Long lean period.

(b) Growing of mixture is on the increase.

(c) Berseem and lucerne are cultivated for dairy stock where irrigation is available.

PROBLEM : **29.** The extent and quality of natural pastures.

INVESTIGATOR : J. M. Smith, Chief Veterinary Officer.

OBSERVATION : No survey has been made. There are no artificial pastures or grasslands, and natural pastures are relatively poor and very limited ; gradually decreasing owing to swamp reclamation and extension of cultivation. No wide expanse of pasturage of savannah type. Average rainfall varies from 128 mm. in Jericho to 840 mm. in Safad. Wet season is from November to April, summer is quite dry.

PROBLEM : **30.** The proper regulation and use of forest grazings.

INVESTIGATOR : F. J. Fear, Chief Forest Officer.

OBSERVATIONS : Prohibitive action to control enormous damage done to forest growth by grazing of domestic animals can be introduced only with discretion as advance is made in improved stock breeding, fodder production, pasture improvement and determination of grazing rights.

STRAITS SETTLEMENTS AND FEDERATED MALAY STATES. (59.5)

Publication : Report of Research, Economic and Agricultural Education Branches of Department of Agriculture for year 1932. Kuala Lumpur, 1933.

RESEARCH : **31**. (a) Effect on yield and composition of *Panicum maximum* of (i) frequency of cutting, and (ii) various fertilizers on both light and heavy soils.

(b) Analysis of principal fodder and pasture grasses, including natural pasture.

(c) Test of fodder plants other than herbage (including *Vigna sinensis*).

INVESTIGATOR : C. D. V. Georgi, Acting Agricultural Chemist, and associates.

RESULTS : (a) Harvesting and analysis have been commenced.

(b) Principal constituents of natural pasture were found to be *Axonopus compressus*, *Bulbilis dactyloides* and *Imperata cylindrica*. Feeding value of these wild grasses before approaching flowering stage is not inferior to that of guinea grass at or near the flowering stage, which is the normal state at which this grass is fed and at which it constitutes a well-balanced ration.

(c) *Vigna sinensis* before flowering is rich in protein, and offers possibilities as a useful substitute for lucerne hay.

KENYA. **(67.62)**

Publication : Department of Agriculture Annual Report, 1932. Nairobi, 1933.

RESEARCH : **32**. (a) General improvement of the grasslands, natural or cultivated.

(b) Effect of different intensities of grazing and grass burning on natural pastures, of *Themeda triandra*, *Pennisetum clandestinum* and *Cynodon plectostachyum* respectively.

(c) Seeding habits of chief grasses.

(d) Study of individual pasture species.

(e) Fodder plants for feeding green or ensiling.

INVESTIGATOR : D. C. Edwards, Officer in Charge of Grassland Improvement.

RESULTS : Published elsewhere in this issue of *Reviews*.

RESEARCH : **33**. Various items on pastures and forage crops.

INVESTIGATORS : Veterinary Research Officer, Live Stock Officer and Officer in Charge of Research at Government Farm, Naivasha.

COLLABORATION : Section of Animal Industry with Officer in charge of Grassland Improvement and Rowett Research Institute, Aberdeen.

RESULTS : See Report pp. 213-6, 223-4, 230, 253, 293-4, 304, 309.

TANGANYIKA TERRITORY. **(67.82)**

Publication : Annual Report of the Department of Veterinary Science and Animal Husbandry, 1932. Dar-es-Salaam. 1933.

RESEARCH : **34**. (a) Value of certain protein concentrates available in Tanganyika [*Phaseolus vulgaris*, *Vigna sinensis*, groundnut cake (*Arachis*), seeds of blue lupin (*Lupinus* sp.), lucerne hay, cotton seed.]

(b) Nutritive value of groundnut tops (*Arachis*).

(c) Leaves of *Disperma trachyphyllum*, a local shrub.

(d) Nutritive value of *Acacia* pods.

(e) Maize and millet brans, maize silage.

(f) Cassava roots (*Manihot* spp.) as livestock fodder.

(g) Digestibility of hay (chiefly *Cynodon plectostachyum*) from the Laboratory Farm, Mpwapwa (nutritive value when cut at different periods of year, digestibility of hay from six-weeks' old grass, digestibility of aftermath hay, and of season's growth cut in May or in August).

(h) Comparative studies of composition of hay and silage.

INVESTIGATOR: M. H. French, Biochemist.

RESULTS: A large amount of data obtained from analytical and other studies are presented (see Report, pp. 29-63).

RESEARCH: **35**. The suitability of the Njombe grassland area (Southern Highlands) for woolled sheep.

INVESTIGATORS: H. E. Hornby, R. R. Staples and M. H. French.

RESULTS: A stock farm has been established (see Report, p . 78). Among the research carried out on this land are analyses of soils and pastures (M.H.F.) and pasture investigations (R.R.S.). See below (items 36 and 37).

RESEARCH: **36**. Chemical investigations on Njombe Stock Farm, including soil and pasture analyses.

INVESTIGATOR: M. H. French, Biochemist.

RESULTS: Pastures generally mineral-deficient. Phosphorus low, but higher than would be expected from such excessively deficient soils. Indigenous plants have developed remarkable powers of assimilating this element. Potash analyses extremely low, lime about one-quarter of that for normal hay, soda low and chlorine very low. Crude protein low, fibre high. Green grass has nearly twice the protein and soluble ash contents of the dried grass. All mineral constituents showed a rise, but especially the potash fraction.

RESEARCH: **37**. (a) Pasture investigations on Njombe Stock Farm.

(b) Comparison of the co-dominants, *Themeda triandra*, *Trichopteryx simplex* and *Hyparrhenia nyassae*, as regards grazing value and resistance to tramping.

(c) Botanical survey of area.

(d) The effects of grass burning on the pasture, and time of burning.

(e) Effects of close grazing with or without burning.

(f) Establishment of cultivated pastures.

(g) Discovery of a suitable pasture legume.

(h) Information as to pasture derived from observations on cattle.

INVESTIGATOR: R. R. Staples, Research Officer (Pasture).

RESULTS: (a) Of some 377 species collected, only 96 are grasses; the remainder are mostly small perennial herbs; legumes are particularly well represented. Prominent on the margins of the rain forest are a fair number of forest species of shrubs and trees. The grass genera dominant on the hilltops and slopes are the species of *Themeda*, *Trichopteryx* and *Hyparrhenia* mentioned. The wetter vlei areas have an entirely different grass flora.

(b) The first two species are poorly adopted to withstand tramping; *Hyparrhenia* may be expected to increase.

(c) Naming of grasses by the East African Agricultural Research Station at Amani and at Royal Botanic Gardens, Kew, is proceeding.

(d) Ungrazed grass becomes highly inflammable during long dry season; burning almost inevitable, and considered advisable over part of the farm as a means of producing palatable nutritious young grass initially clean from worms. Experiments are in progress with nine different times of burning.

(f) Appreciable improvement on the natural pasturage, particularly for the dry season is feasible without use of artificial fertilizers; with this help improvement would be an easy matter.

(g) Particular attention is being paid to native legumes, plentiful in the local flora, as well as to introduced species.

(h) With good range management something more than a maintenance ration for cattle is furnished by pasture alone during eight months of the year; supplementary feeding is desirable for all, and necessary for lactating cows, during the remaining four months.

SOUTH AFRICA. (68)

Publication : Annual Report of Department of Agriculture for year ended 30th June, 1933.

SOURCE : *Farming in South Africa* Vol. 8. No. 93. December 1933.

RESEARCH : **38** (a) Sowing down of woolly finger grass (*Digitaria* Strain P. 27).
(b) Selfing and selection in *Digitaria*.
(c) Laying down *Digitaria* pastures by hand.

INVESTIGATOR : Dr. I. B. Pole Evans, Chief, Division of Plant Industry, and Assistants.

RESULTS : (a) The sowing method has considerable advantages over the hand-planting method.
(b) It is desired to make the strain less mixed, to procure a homogeneous stand of the best elements composing it, without any sacrifice of seeding ability.
(c) An attempt to lay down a two-acre plot behind a double-furrow plough by means of rooted runners failed. The ordinary method of hand-planting is laborious, expensive and slow.

RESEARCH : **39**. (a) Pasture establishment.
(b) Selection of strains of *Digitaria*.
(c) Rearing fat lambs on *Digitaria* pastures.
(d) Breeding and seed production in *Digitaria*.

INVESTIGATOR : Dr. I. B. Pole Evans and assistants.

LOCATION : Prinshof and Rietondale Pasture Experiment Stations.

RESULTS : (a) Some of the grasses showed remarkable properties for establishing themselves under droughty conditions and on poor soils.
(b) A list is given of the most promising strains out of some 150 at the two stations.
(c) Preliminary results indicate ultimate success.
(d) Arrangements made for beginning work.

RESEARCH : **40**. (a) Chemical analyses of Karroo bushes.
(b) Chemical analyses of pastures in coastal district of East London and Grahamstown.
(c) Water content of Karroo plants.
(d) Nitrogen metabolism and pigments of *Tribulus*.
(e) Carrying capacity and palatability of pastures.
(f) Recovery of *Pentzia* and *Phymaspermum* veld after cutting and grazing.
(g) Feeding sheep with dried powdered Karroo bush wetted with water.

INVESTIGATORS : Chief, Division of Plant Industry and Dr. Marguerite Henrici.

COLLABORATION : Division of Veterinary Research [item (d)].

LOCATION : Veld Reserve, Fauresmith.

RESULTS : (a) Paper in preparation.
(b) Paper in preparation ; pastures very poor in protein and generally poor in phosphorus.
(c) Useful data were obtained regarding resistance of bushes to continued lack of water.
(d) Research carried out in connection with heavy losses caused by geeldikkop in the district.
(g) Powder eagerly eaten.

RESEARCH : **41**. (a) Breeding of non-shattering strains of soybeans.
(b) Irrigation of lucerne.

(c) Transpiration experiments in relation to irrigation practice.

(d) Winter cereal and lucerne grazing trials.

(e) Selection of new varieties, use of more suitable times for planting and better methods of grazing for lucerne and winter cereals.

(f) Drought-resistant fodders (salt bush and cactus).

(g) Variety trials of Kaffir sorghums.

INVESTIGATORS: Chief, Division of Plant Industry and associates.

LOCATION: Experiment Stations at the Colleges of Agriculture (Cedara, Natal; Glen, Orange Free State; Grootfontein, Middelburg, C.P.; Potchefstroom, Transvaal; Stellenbosch—Elsenberg, University of Stellenbosch).

RESULTS: (a) Good progress made, yield and drought resistance most satisfactory.

(b) At Grootfontein it has been found that the heavier the irrigation, the higher the yield, but the lower the return per unit of water. It does not follow that the lighter waterings are the most economical. Applications of approximately 3 in. made twice for each cutting are likely to result in the greatest profit.

(c) A silage or forage type highly immune to witchweed infestation will be available for distribution within the next two years.

SOUTHERN RHODESIA. (68.9)

Publication: Report of Division of Plant Industry for the year 1932.

SOURCE: *Rhodesia Agricultural Journal* 30. 903-18. 1933.

RESEARCH: **42.** (a) Ascertaining the most suitable grasses and legumes for improved pastures on non-irrigated vlei soils.

(b) Establishment of improved pastures on upland soils.

(c) Experiments in making veld grass silage in stacks or pits.

(d) Breeding of non-shattering strains of soybean.

INVESTIGATOR: H. G. Mundy, Chief, Division of Plant Industry and associates.

LOCATION: Research Farm, Marandellas (a), and Salisbury Experiment Station.

COLLABORATION: African Explosives and Industries, Ltd.

RESULTS: (a) Outstanding exotics are *Holcus lanatus*, *Paspalum dilatatum* and *Paspalum* sp. (upright paspalum). *Trifolium repens* is best legume. Best indigenous grasses are *Haemarthria fasciculata* and *Paspalum scrobiculatum*; the former combines well with white clover.

(b) Indigenous species best; especially *Digitaria* and *Brachiaria dictyoneura*.

(c) Stack silage more economical but results unfavourable.

(d) Not yet possible to combine this quality with maximum yield of grain.

Publication: Final Report, Gwelo Municipal Demonstration Station. 1933.

SOURCE: *Rhodesia Agricultural Journal* 31. 195-212. 1934.

RESEARCH: **43.** (a) Legumes for hay and grain (*Dolichos*, *Mucuna*, *Vigna*, *Glycine*, *Cicer*, etc.)

(b) Sunflowers (*Helianthus*) for fodder or silage.

(c) Sudan grass (*Andropogon sorghum* var. *sudanense*) as an annual grass-type hay crop.

(d) Undersowing maize with legumes.

INVESTIGATOR: S. D. Timson, Assistant Agriculturist.

CANADA. (71)

Publication: Report of Minister of Agriculture for the Dominion of Canada for year ended March 31st, 1933. Ottawa.

RESEARCH: **44.** (a) Pasture improvement.

(b) Application of fertilizer to pasture.

INVESTIGATORS : Division of Field Husbandry.
LOCATION : Central Experimental Farm, Ottawa.
COLLABORATION : Branch Experimental Farms.
RESULTS : (a) Outstanding cause of failure in pasture land in Eastern Canada is deficiency in soil fertility.

(b) Applications at one centre increased amount of grass 98 per cent and more than doubled carrying capacity.

RESEARCH : **45**. (a) Improvement of hay as pasture crops for western conditions by breeding.
(b) Breeding of *Medicago* for increased seed production.
(c) Breeding of *Trifolium pratense* over a number of years.
(d) Plant breeding with *Melilotus albus, Phleum pratense, Agropyrum* spp., *Zea mays*, mangels and swedes.
(e) Breeding of soybeans for productivity, earliness and quality.
(f) Study of native vegetation of ranges, especially of changes which take place under different systems of grazing.
(g) Experiments on different species and seeds mixtures for pasture.
(h) Comparative tests of varieties of alfalfa, red clover and sweet clover.
(i) Introduction and testing of new species and varieties of forage plants, including *Lolium perenne* and *Lespedeza*.
INVESTIGATORS : Division of Forage Plants (Dr. L. E. Kirk and assistants).
LOCATION : Central Experimental Farm, Ottawa, and Dominion Forage Crops Laboratory, Saskatoon, Sask.
RESULTS : (a) Pressing need for better varieties of hardy and drought resistant grasses and legumes, especially for pastures. Crested wheat grass outstanding for drier prairie areas of Western Canada.

(b) Use is being made of certain mother plants found to be self-fertile and independent of insect pollination.

(c) A strain highly adapted to Ontario has resulted.

(d) With the grasses, strains for pastures are the chief objective.

(f) Principal forage plants of range areas of southern Alberta and Saskatchewan have been identified ; palatability, nutritive value and response to different methods of grazing have been determined.

Publication : Division of Botany. Report of the Dominion Botanist (H. T. Güssow) for year 1930. Ottawa, 1931.
RESEARCH : **46**. Surveys for Eastern Pasture Improvement Committee.
INVESTIGATOR : H. Groh.
LOCATION : Central Laboratory, Ottawa.
RESULTS : At Fredericton this is the third annual inspection, at the other five stations either the second or the first. Surveys made in different months each year. An evaluation of some results should be possible after another year. Preliminary remarks are made regarding dissimilarity between pasture stands, and effect of fertilizer applications.

RESEARCH : **47**. (a) Selection of *Phleum pratense* resistant to *Puccinia graminis* var. *phlei-pratensis*.
(b) Resistance of varieties and strains of clovers to mildew (*Erysiphe Polygoni*).
INVESTIGATOR : R. R. Hurst.
LOCATION : Dominion Laboratory of Plant Pathology, Charlottetown, Prince Edward Island.

RESULTS: (a) Results support statement of Barker and Hayes (*Phytopath.* 14. 363-71. 1924) that the production of varieties of timothy which will be resistant to stem rust in different regions may be accomplished rather easily, inasmuch as resistance appears to be a dominant factor.

(b) Definite indications appear of mildew resistance in 16 of the 37 strains. Varieties from Europe were generally quite resistant.

RESEARCH: **48**. A study of the root rots of sweet clover (*Melilotus albus*) in Western Canada.
INVESTIGATOR: G. B. Sanford.
LOCATION: Dominion Laboratory of Plant Pathology, Edmonton, Alberta.
COLLABORATION: M. W. Cormack, Laboratory, and Lacombe Experimental Farm.
RESULTS: Observations have been made on *Plenodomus Meliloti* (figured).

Publication: Report of Minister of Agriculture, Province of Ontario, 1932.
RESEARCH: **49**. (a) Survey of Ontario pastures.
(b) Effect and value of fertilizers.
(c) Seeds mixture trials.
INVESTIGATORS: Ontario Agricultural College and Experimental Farm.
CO-OPERATION: Departments of Field Husbandry, Animal Husbandry, Chemistry and Farm Economics.

UNITED STATES OF AMERICA. (73)

Publication: Fifty-fifth Annual Report of the North Carolina Agricultural Experiment Station for year ending 30th June 1932. Progress Report for year ending 1st December, 1932.
RESEARCH: **50**. (a) Crop rotations.
(b) Forage crop studies [*Medicago, Trifolium pratense, Crotalaria, Pisum* (Austrian), *Vicia, Glycine*].
(c) Carrying capacity of native reeds (*Arundinaria tecta*).
(d) Methods of pasture development for beef cattle and other livestock.
(e) Value of *Lespedeza* as a supplementary pasture.
(f) Comparative value of alfalfa and *Lespedeza* hay.
RESULTS: See Report pp. 19-26 (a), 43 (b), 48 (c), 49 (d), 53 (e and f).

Publication: Work of the Missouri Agricultural Experiment Station. Year ending June 30th, 1932. Columbia, Missouri, July, 1933.
RESEARCH: **51**. (a) Protein supplement for cattle on *Poa pratensis* pasture.
(b) Systems of grazing *Poa pratensis* pastures.
(c) Study of Missouri pastures.
(d) Comparison of grain sorghum with maize for grain and hay production.
(e) Varieties and selections of soybeans.
RESULTS: See Report, pp. 9, 10, 11, 16 and 17.

BRITISH GUIANA. (88)

Publication: Administration Report of Director of Agriculture for year 1932. Georgetown, Demerara, 1933.
RESEARCH: **52**. (a) Observations on optimum periods of cutting, yield, duration without replanting, etc., of *Tripsacum laxum, Pennisetum purpureum, Melinis minutiflora, Panicum maximum, P. barbinode* and Uba cane.

(b) Establishment of areas with either *Asystasia gangetica* or *Alysicarpus vaginata* planted through the existing pasture grasses.
(c) Suitability of *Alysicarpus* for grazing.
(d) Establishment of *Spartina Townsendii* on foreshore.
(e) Observation on extent and spread of *S. brasiliensis*.

NEW ZEALAND. **(93.1)**

Publication: Annual Report of the Department of Agriculture for 1932-33. Wellington, 1933.

RESEARCH: **53.** (a) Mineral content of pasture investigations (use of limonite as a stock lick).
(b) Ragwort (*Senecio jacobaea*) as an interfering factor in bush sickness.
(c) Pampas grass (*Gynerium* (*Cortaderia*) *argenteum*) and toetoe as fodder.
(d) Contamination factor in pasture analysis.

INVESTIGATORS: Chemistry Section (B. C. Aston, Chief Chemist).

LOCATION: Dominion Laboratory, Wellington.

COLLABORATION: Officers of other Divisions (Veterinary and Meat Inspection).

RESULTS: (b) Importance of controlling ragwort even greater in bush-sick areas, owing to possibility of confusion of symptoms. The use of sodium chlorate is attended by risks of fire; ammonium thiocyanate has given promising results.
(c) Practical results are promising.
(d) A study has been made of the relationship of alumina content of herbage to soil contamination; conclusions published in *Trans. N.Z. Inst.*

RESEARCH: **54.** Seed Certification.

INVESTIGATOR: J. W. Hadfield, Agronomist.

LOCATION: Plant Research Station, Palmerston North.

RESULTS: Section on p. 37 gives progress of scheme.

RESEARCH: **55.** (a) Comparative trials of overseas and local (Marlborough) lucerne; object to produce superior hay type, and a hay and grazing type for dry conditions.
(b) Pollination in lucerne.
(c) Practical method of tripping lucerne flowers in the field.

INVESTIGATOR: J. W. Hadfield, Agronomist.

LOCATION: Plant Research Station, Palmerston North, and in lucerne district in Marlborough (55c.).

RESULTS: (a) Variation in yield, form and habit between the different families which are now available is nearly as great as that shown by their parents. The best plants in the best L_1 families will be selfed, and the best L_2 plants will be intercrossed in order to restore vigour. Comparison of parents of best L_1 families and commercial Marlborough will be made.

RESEARCH: **56.** Production of strains of pasture plants.
(a) *Lolium perenne*.
(b) Italian ryegrass, Western Wolth's and Wimmera ryegrass, *Lolium* spp.
(c) *Dactylis glomerata*.
(d) *Holcus lanatus*.
(e) *Agrostis tenuis*.
(f) *Paspalum*.

(g) *Agropyron* species.
(h) *Trifolium repens, T. pratense, T. subterraneum.*
(i) *Lotus major.*

INVESTIGATOR: E. Bruce Levy, Agrostologist.
LOCATION: Plant Research Station, Palmerston North.
RESULTS: Report deals with certificational trials, comparative trials, elite strain work, broadcast trials, single plant trials. A beginning has been made with genetical work in *Trifolium repens* and *T. pratense*. For full details see report pp. 39-41.

RESEARCH: **57**. (a) Seed production experiments.
(b) Suppression of annuals in pastures.
(c) Regrassing secondary growth country.
(d) Ecological work on grassland.
(e) Greenkeeping.
(f) Alternate mowing and grazing trials.

INVESTIGATOR: E. Bruce Levy, Agrostologist.
LOCATION: Plant Research Station, Palmerston North, and outlying districts.
RESULTS: See Report, p. 41.

RESEARCH: **58**. (a) Application of the "alternate mowing and grazing" technique of measuring grassland production in fertilizer trials and in comparative tests of herbage species.
(b) Method and frequency of application of various fertilizers.
(c) Comparison of strains of ryegrass, clover and cocksfoot, and of seeds mixtures.
(d) Test of merits of Aberystwyth sheep tethering technique.

INVESTIGATOR: A. W. Hudson, Crop Experimentalist.
LOCATION: Palmerston North, Marton Experiment Farm, Ruakura Farm of Instruction, Gore Experiment Area, and elsewhere.
COLLABORATION: Analytical Chemist (B. W. Doak) and Agrostologist (E. Bruce Levy).
RESULTS: (d) Too laborious for present use.

RESEARCH: **59**. (a) Grazing trials on dairy farms to determine effects of nitrogen.
(b) Grazing trials to determine relative value of "certified" and other ryegrass.
(c) Observational topdressing experiments.
(d) Demonstrations and trials of ryegrass and clovers.
(e) Inoculation of legumes.
(f) Seed production.

INVESTIGATOR: A. W. Hudson, Crop Experimentalist.
LOCATION: Scattered.
COLLABORATION: Field Officers of Fields Division; Agrostologist (d and f); Mycologist (e); Seed Analyst (f).
RESULTS: See Report, pp. 42-3.

RESEARCH: **60**. (a) Preparation of cultures of lucerne nodule organism.
(b) Clover nodule organism.

INVESTIGATOR: G. H. Cunningham, Mycologist.

LOCATION: Plant Research Station, Palmerston North.
RESULTS: (a) An increase of 80 per cent in amount of seed treated, as compared with previous season.
(b) Object is to see if inoculation improves establishment of red and white clovers.

RESEARCH: **61.** (a) Defective germination of *Lolium perenne*.
(b) Selection of lines of *Lolium perenne* resistant to *Puccinia graminis* and *P. coronata*.
(c) Clover virus diseases.
INVESTIGATOR: G. H. Cunningham, Mycologist.
LOCATION: Plant Research Station, Palmerston North.
RESULTS: (a) Pathogenicity of four fungi which have been isolated is being tested.
(c) Red clover virus may be transmitted to garden peas; virus reduces herbage by 50 per cent.

RESEARCH: **62.** (a) Systematics of New Zealand grasses.
(b) Poison plants.
INVESTIGATOR: Dr. H. H. Allan, Systematic Botanist, and V. Zotov.
LOCATION: Plant Research Station, Palmerston North.
RESULTS: (a) Manuscript of book on taxonomy of New Zealand grasses nearing completion. An introductory book on grasses of New Zealand is being submitted for publication.
(b) A series of articles is being published in *N.Z.J. Agric.*

RESEARCH: **63.** (a) Purity inspection of certified *Lolium perenne*.
(b) Deterioration of grass seed during shipment from New Zealand.
(c) Low germination of *Lolium perenne*.
(d) Cyanogenetic reaction of *Trifolium repens*.
(e) New Zealand *Paspalum* seed.
INVESTIGATOR: N. R. Foy, Seed Analyst.
LOCATION: Plant Research Station, Palmerston North.
RESULTS: (b) Tests are being made with trial shipments of Chewings fescue (*Festuca* sp.).
(c) With a drier season in certain districts, quite reasonably high germinations have been recorded, but there is a large proportion of 1933 crop quite without commercial value (Cf. item 61a).
(d) Picrate paper is used as an indicator of HCN; improved technique permits completion of test in eight days. Test results will prove of great assistance in strain diagnosis.
(e) Studies are being made with a view to recommending a practical harvesting and dressing procedure, so that New Zealand seed can be produced to compare favourably on a purity and germination basis with Australian seed.

RESEARCH: **64.** (a) Soil and pasture analyses in connection with mowing trials (Cf. items 58a and b).
(b) Chemical method of determining type in *Trifolium repens* (Cf. item 63d).
INVESTIGATOR: B. W. Doak, Chemist.
LOCATION: Plant Research Station, Palmerston North.
COLLABORATION: Agrostologist, Crop Experimentalist and Seed Analyst.
RESULTS: (b) Excellent correlation exists between type in white clover and HCN content.

Publication: Seventh Annual Report of New Zealand Department of Scientific and Industrial Research for year 1932-33.

[RESEARCH: For items in research programme of Plant Research Station, Palmerston North, see items 54-63 above.

For report of B. C. Aston on "Mineral content of pastures," see item 53 above.]

RESEARCH: **65.** (a) Iron content of pasture, native plants and fodder crops in relation to "bush sickness."

(b) Effect of soil type and fertilizer on iron content of pasture plants.

(c) Cyanogenetic glucosides in Nelson pasture plants.

(d) Effect of nitrogenous manures on yield and chemical composition of typical dairying pastures.

INVESTIGATORS: T. Rigg and H. O. Askew.

LOCATION: Cawthron Institute, Nelson.

RESULTS: (a) Data do not indicate that animals would receive a greater amount of iron from native bush plants than from typical "bush-sick" pastures; the fodder plants investigated are various turnips and swedes.

(b) The various species tested elaborated different amounts of iron; highest figures for iron were obtained from *Trifolium repens* and *Lolium perenne*, lowest from *Agrostis alba* and *Danthonia pilosa*. *Trifolium pratense* was intermediate. The varying effect of fertilizer treatment on iron content is noted.

(c) Grasses produced only small quantities of HCN on fermentation. In legumes, greater variation was found with individual species. Data are given (p. 22) and a discussion of HCN content in white clover pastures in relation to stock follows.

(d) For results see pp. 23-4.

AUSTRALIA. **(94)**

Publication: Seventh Annual Report of Council for Scientific and Industrial Research for year ended 30th June, 1933.

RESEARCH: **66.** (a) Preparation of a grassland map of Australia.

(b) Study of twelve selected grasses as regards conditions of seed and germination, rate of growth, root growth, tillering, water requirement, drought resistance, seed formation and capacity for self-establishment.

(c) Elaboration of a method of determining relative drought resisting capacity of grasses.

(d) Strain and growth studies in *Themeda australis*.

(e) Production of improved strains of *Phalaris stenoptera*, *P. coerulescens* and *Danthonia semi-annularis*.

(f) Stage of harvesting *Phalaris* seed to avoid loss by shattering.

INVESTIGATORS: Division of Plant Industry (Chief: Dr. B. T. Dickson).

LOCATION: Canberra, Duntroon, etc.

RESULTS: (a) Data collected now being translated to map.

(b) Preliminary results show that seed of *Eragrostis virescens* will germinate only in light, seed of *Agropyron* spp. will not germinate unless allowed to drop off, seed of *Ehrharta erecta* must be allowed to fall naturally before it will germinate naturally.

(c) A promising method has been evolved; a publication will appear on the subject.

RESEARCH: **67.** Entomological control of noxious weeds (*Hypericum perforatum*, *Xanthium pungens*, *Senecio jacobaea*, *Pteridium*).

INVESTIGATORS: Senior Entomologist (G. A. Currie), S. Garthside and S. G. Kelly.

LOCATION: Division of Economic Entomology, Canberra (G.A.C.), Farnham Royal, England (S.G.), and Manhattan, Kansas (S.G.K.).

RESEARCH: **68.** (a) Lucerne flea or clover springtail (*Sminthurus viridis*).
(b) Red-legged earth mite (*Halotydaeus destructor*).
(c) Underground grass grub.
INVESTIGATORS: H. Womersley (a and b); A. L. Tonnoir (c).
LOCATION: Denmark State Farm, Western Australia (a and b).
RESULTS: (a and b). All lucernes and most clovers and grasses were severely affected; the perennial strain of *Trifolium pratense* (Montgomery Red) was practically untouched and in excellent condition. Work is in progress on a promising predatory mite, *Biscirus lapidarius*.

RESEARCH: **69.** Toxicity of *Erythrophloeum* and *Senecio jacobaea*.
INVESTIGATORS: Melbourne University, Veterinary Research Institute.
RESULTS: Toxicity was proved in both cases. Animals refuse to eat the former.

RESEARCH: **70.** (a) Estimation of cystine and cysteine in grasses and other fodder plants.
(b) Top-dressing of sulphur- and phosphorus-deficient pastures with sulphur and rock phosphate.
(c) Possible relationship of a diet of *Selliera radicans* to "Coast diseases."
INVESTIGATORS: Division of Animal Nutrition.
RESULTS: See Report, pp. 38-49.

Research: **71.** Mineral content of pastures.
INVESTIGATORS: Empire Marketing Board, University of Adelaide and Council of Scientific and Industrial Research.
LOCATION: Waite Agricultural Research Institute.
RESULTS: For further details see following items on research at Waite Institute.

Publication: Report of Waite Agricultural Research Institute, 1925-1932. Adelaide, 1934.
RESEARCH: **72.** (a) Top-dressing of natural pastures with equivalent quantities of phosphoric acid.
(b) Effect of superphosphate on the yield, botanical and chemical composition and stock-carrying capacity of natural pastures.
(c) Management of natural pastures.
(d) Pasture technique.
(e) Limitations to the value of top-dressed natural pastures.
(f) Preliminary tests with cultivated pasture plants.
(g) Sward trials and pasture establishment tests.
(h) Investigations of pasture establishment at country centres.
(i) Pasture management investigations.
(j) Rotational grazing trials with dairy cattle (Mount Barker).
(k) Strain investigation of perennial grasses.
(l) Mineral content of pasture species grown in pot cultures.
(m) Nitrogen fixation by leguminous plants.
(n) The germination of pasture seeds.
(o) The identification of herbage plants by vegetative characters.
(p) The establishment of saltbushes.
INVESTIGATORS: Prof. A. E. V. Richardson and staff of Institute.
LOCATION: Glen Osmond, South Australia, and field stations.

RESULTS : A list of publications is available on request. Articles have appeared in the following Herbage Bureau publications : Bull. No. 7 ; Bull. No. 14 ; *Herbage Reviews* I. 96. 1933, and this number of *Reviews* (Trumble and Cashmore on *Phalaris*).

Other details of research at the Waite Institute will be found in Part A of Herbage Publication Series, Bull. 14, to which refer for a complete review of herbage and forage crop research in Australia.

Publication : Report of Agricultural Chemist, Queensland Department of Agriculture and Stock, 1933.

RESEARCH : **73.** (a) Sampling of plots of sorghum and Sudan grass at varying stages of growth for determination of HCN content.

(b) Chemical analyses of grasses, forage plants and pastures.

INVESTIGATOR : E. H. Gurney, Agricultural Chemist.

LOCATION : Lawnton Trial Plots.

RESULTS : (a) HCN content of first cuts of Sudan grass is less than half that of sorghums ; later cuts show greater difference in favour of Sudan grass. Feeding in seed stage can be considered as safe.

(b) Tables 4 and 5 give results of analyses of grasses, mixed pasture and ensilage composed of old *Paspalum*.

Publication : Report of Seeds, Stock Foods, Fertilizers and Pest Destroyers Investigation Branch, Queensland Department of Agriculture and Stock. Brisbane, 1933.

RESEARCH : **74.** (a) Chemical analyses of pasture and forage plants.

(b) Relative value of pasture varieties and strains for Queensland conditions.

(c) Seed certification.

(d) Poisonous properties of sweet sorghums and Sudan grass.

INVESTIGATORS : Fred F. Coleman and F. B. Coleman.

COLLABORATION : C. T. White, Government Botanist, and E. Gurney, Agricultural Chemist.

LOCATION : Scattered trial plots.

FIJI **(96.1)**

Publication : Annual Bulletin of Divisional Reports, Department of Agriculture, 1932. Suva, 1933.

RESEARCH : **75.** (a) Trial with *Melinis minutiflora*.

(b) Trial with lucerne.

(c) Trial with *Chloris gayana*.

INVESTIGATOR : Director of Agriculture (A. C. Barnes) and Agricultural Officers.

LOCATION : Government Experimental Station, Navuso.

RESULTS : (a) 50 per cent strike obtained by planting cuttings. Feeding and grazing values not yet known.

(b) Doubtful whether crop will be of any value.

(c) One plot was reserved for seed supply, the other for feeding experiments. Results indicate that value of this grass in wet zone is doubtful.

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The second in this series of bibliographies is compiled from sources similar to those of the first and is also limited to the period 1925 onwards.

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SOVIET RESEARCH

SELECTION OF FORAGE CROPS IN THE STEPPE PART OF UKRAINE.

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INTRODUCTION.

The development of animal husbandry in the arid steppes of Ukraine depends primarily upon the building up of a permanent and stable fodder supply. In achieving this one of the principal factors is plant breeding. The material and data so far collected concerning the breeding value of certain forage crops, e.g. Sudan grass, sorghum, and to a certain extent lucerne, etc., enable us at the present time to trace the trend which the breeding of forage crops must follow in these districts. The principal requirements are the selection and breeding of plants most resistant to drought and ensuring a high stable yield of green forage and hay of high feeding value.

SELECTION OF PLANTS AND INITIAL MATERIAL FOR BREEDING.

The first necessary step is to find a group of forage crops with a high production of true proteins and starch per unit area, at a minimal expense and, under all possible extremes of climate, namely, drought, severe winter, etc.

A comparative survey of forage crops made in 1929 showed that sorghum, Sudan grass and maize among annuals, and lucerne among perennials, are the most productive.

Owing to an almost entire absence of natural grasslands in these districts, the chief method of solving the fodder supply problem lies in correct organization of field sowing. Obviously, the breeder desirous of building up productive and drought resistant forms must employ all possible ways, using the world's diversity of the species selected, and also devoting his attention to the search for forage crops in the indigenous flora. Recent expeditions of the U.S.S.R. Research Institute of Fodder to Armenia, North Caucasus, West Siberia, etc., have confirmed this statement. Exceptionally drought resistant forms of *Medicago falcata, M. coerulea* and *Onobrychis* were found and a rich initial stock of *Agropyrum* and *Bromus* collected. It is obviously possible to select from such a diversity many geographical races suitable for the Ukrainian steppes.

BREEDING OF GRASSES.

Sudan grass, an annual cross-pollinating plant, is exceptionally drought resistant and, in favourable years, capable of producing 4-5 cuts. Inbreeding analysis of agricultural populations showed that it is a very polymorphic plant.

The two articles now published by I. V. Korejša belong to a series of three which will serve to give an idea of the type of forage crop work in progress at Odessa, the starting point of the new theory of vernalization. The third article of the present series, on sorghum × Sudan grass hybrids, will be published in the next issue of *Reviews*.

It may appear that certain of the articles published in this new section on research in U.S.S.R. are contrary to the rule that original results cannot be published in these columns. It should be noted, however, that this rule is being borne in mind and that the articles in question are to be regarded as abstract-reviews of work which has been or is about to be published in the Soviet Union, written by the Russian author rather than by the staff of this Bureau.

In formative processes, a large number of biotypes was selected, agriculturally valuable in respect of the rate of growth, tillering, character of stems, nutrient content (true proteins and sugars), etc. It is impossible to describe the very wide range of forms obtained by inbreeding within the scope of an article. Some forms may be mentioned. Thus, there are selected dwarf forms (45-50 cm. in height) with vigorous tillering which produces 75-110 stems per bush, and giant forms (2½ - 3 m. in height) which grow rapidly and produce soft green forage with varying content of true proteins and sugars in their stems.

The analysis of F_1 obtained by crossing various inbred lines reveals even wider possibilities. Here lies the key to the solution of the problem of producing polyhybrids of Sudan grass exhibiting permanent heterosis of the required characters. Such varieties have already been obtained in the sunflower by D. I. Baranskiĭ (Department of Oleiferous Plants of this Institute). Of no less interest is the genetic analysis of sorghum × Sudan grass hybrids made by A. M. Favorov on very large material, which enables the breeder to build up the required forms of Sudan grass.

Eragrostis abyssinica was brought from Abyssinia by N. I. Vavilov in 1927. This new forage crop is very valuable as an annual and rapidly growing plant. As a result of breeding tests, it is possible to select a number of forms valuable in respect of green forage yield and feeding qualities and thus to include this plant among those suitable for the steppes.

Comparative study of various forage crops shewed (Table 1) that among annuals the first place is taken by Sudan grass, particularly by Nos.2/288, 1/278 and 4555 bred at this Institute, which exceed the yield of agricultural populations by 50 per cent. The yield of teff (*Eragrostis abyssinica*), although considerably inferior to that of Sudan grass, can nevertheless be raised by mass or individual selection from the existing mixtures.

Mohar (*Panicum italicum* ssp. *moharica*) and Čumiza (*Setaria italica* var. *maximum* Alf.) are also of great interest. Among their defects are low yield, slow growth and somewhat coarse hay as compared with Sudan grass, which can to a great extent be eliminated in the process of breeding.

TABLE I.

Name of plants.	Green forage yield. Centners per ha.	Hay yield. Centners per ha.	Percentage of hay.
Sudan grass 4555	239.39	50.52	21.10
,, ,, 2/288	276.69	53.53	19.34
,, ,, 1/278	230.37	55.93	24.24
,, ,, population	166.60	—	—
Mohar 255	167.21	40.66	25.31
Čumiza 259	107.67	27.90	25.91
Teff 167	166.00	—	—
Soja + Sudan grass	186.22	42.70	22.91
Mohar 262	126.91	34.89	27.49

Among perennial grasses which deserve attention are *Agropyrum cristatum* and *A. desertorum*, which are sufficiently resistant to drought, and *A. tenerum*, producing hay of good quality.

LUCERNE.

This crop takes the first place among legumes which require study from the breeding point of view in the steppes. Relatively high xerophytism, valuable feeding qualities and value as a preceding crop give it a foremost position among perennial forage crops.

Four years' test (1929-32) shewed that some varieties, such as blue Ukrainian, French, and the acclimatized varieties HOS-HOS Nos. 351 and 600 produce a forage

yield considerably superior to that of the standard Grimm-Zajkevič. A relatively high yield is characteristic of Bokhara lucerne, whereas other Turkestan lucernes are considerably below standard (80 per cent). Canadian Grimm behaved well, but lucernes from the southern states of U.S.A. were inferior to all, being low in yield and hardiness. On the whole, however, the data of the comparative test shewed that, with the exception of the standard Grimm-Zajkevič and some Ukrainian lucernes, there are no truly acclimatized varieties suitable for the arid steppes of Ukraine.

The problems of lucerne breeding for the steppes are briefly as follows. The breeding research on this crop must be directed primarily to :

(1) evaluation of the world's diversity of lucernes and selection from it of the forms suitable for the steppes ;

(2) utilization of this stock as a genofund in formative processes ;

(3) creation of drought resistant and productive varieties by crossing forms from Asia Minor with *Medicago falcata*, thus transferring to the latter the energy of growth of highly productive forms from Asia Minor.

BACTERIOSIS IN SUDAN GRASS IN RELATION TO SELECTION.

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Research on this problem has been concerned with the type of damage observed in inbred forms of Sudan grass (*Andropogon sorghum* var. *sudanense*), and with the resistance of sorghum to bacteriosis. Our results agree exactly with those of Elliot and Smith on a bacterial stripe disease of sorghum.

It is known that the agents of this disease are *Bacterium holcicola*, *B. sorghi* and *Phytomonas andropogoni* ; under favourable conditions the spores penetrate through the stomata and in developing destroy the palisade tissue, thus causing a varying degree of damage to the surface of the leaf. Bacterial damage mainly affects the leaf, but stems and spikes may also be involved, although the latter type is more frequent in sorghum than in Sudan grass. Some investigators (among them Elliot and Smith) consider that it is more convenient to classify the damage induced according to its etiology, as follows :—

(a) Damage of leaf in the form of red spots. This greatly resembles bacteriosis proper, but the causative agents are Saccharomycetaceae.
(b) Damage induced by aphids and other insects in addition to bacterial activity ; this takes the form of medium to large dots.
(c) Damage induced by the most common agents of bacteriosis such as *B. sorghi*, *B. andropogoni*, etc.

The first two types of leaf blade damage are not serious, less common and in most cases do not cause any particular harm in sorghum ; the 3rd type is more widespread and causes a considerable reduction of yield. Hence it is on this type that attention has been concentrated.

As the result of our observations during 1932-33 there could be distinguished a number of different types of damage, sharply differentiated morphologically and characteristic of definite biotypes. It is of interest to note that the type of damage, i.e. the size of the spot, the colour of the damaged areas and their localization, is to a great extent associated with the genotypic characters of Sudan grass types. These data agree almost entirely with those of the American investigators, who recorded that the same agent (*B. andropogoni*) induces a deep red colour of the affected areas

in Early Amber, Silver Top and Sugar Drip, and light red colour in Red Amber, while Kafir strains are less affected and the colour of the damage areas is a red brown. Thus the colour varies with the strain.

The year 1932 was especially favourable because the meteorological conditions in the steppes—the first half of the summer was relatively cold and wet—stimulated the rapid spread of the disease, which infected almost all the forms with which we are concerned in the nursery collection obtained by many years' isolation, individual selection from the agricultural population and hybridization between sorghum and Sudan grass. From among numerous forms of Sudan grass hardly any remained immune, all the 3,569 plots being entirely infected by bacteriosis. Such a season occurs rarely and offers to the breeder an excellent opportunity of testing his material. Among our forms we found two almost entirely immune and a series of intermediate types, which exhibited varying degrees of susceptibility to infection.

With the aid of special observations, description and collection of a herbarium of damage types, the whole of our material could be classified into groups, each combining definite types fairly closely related in respect of their genetic constitution. These groups differ sharply one from the other in the morphological manifestation of damage.

Group I. The damage spreads over the leaves and partly affects the stem. The chlorophyll is entirely disintegrated on the whole leaf blade. The most extensive damage occurs on both sides of the central leaf nerve ; the colour is purple with a reddish tint. Owing to severe exhaustion of the damaged loci and their isolation from the vascular system of the leaf, the chlorophyll between the affected areas also disintegrates. The most intensive degree of damage is reached after the emergence of the raceme. Another type of damage, actually a sub-type of the first, is characterized by a less severe infection, but all the features are entirely identical with the first group. These types occur on dwarf forms of Sudan grass.

Group II. This is characterized by small red spots irregularly scattered on the surface of the leaf blade and in some places merging together into larger spots ; usually the middle part of the leaf is most severely attacked. This type is characteristic of the variegated forms of Sudan grass.

Group III. Almost the whole leaf blade is damaged, the bacterial infection being localized in the sites of the greatest intensity. The functional activity of the leaf ceases entirely and it acquires a purple-red tinge. This type occurs on natural hybrids of Sudan grass × sorghum.

Group IV. The distribution of the damage is irregular. The affected areas are oblate in shape and are confined to the secondary nerves running parallel to the central. In this form nervation is distinctly expressed and the structure of the vascular system reproduces the morphological manifestation of the damages. This type is characteristic of the so-called reedy Sudan grasses.

Group V. Intermediate between Groups IV and I. It occurs only on the broad-leaf forms of Sudan grass and is characterized by the presence of more or less oblate red-brown spots. The affected areas are unevenly scattered on the leaf surface, usually 60 - 70 per cent of the surface of the blade being involved. The size and shape tend towards the type characteristic of the reedy Sudan grass and are conditioned by the structure of the supporting and the vascular tissues. To this group belong also analogous types of damages in which these characters are more distinctly expressed.

Group VI. An interesting type of damage in which the inheritance of the vascular system is manifested. The spots are black and oblate as in reedy forms. This type is characteristic of those hybrids of sorghum × reedy Sudan grass which resemble Sudan grass in their appearance. Other forms of these hybrids, i.e. those resembling sorghum (which might be termed "sorghum-like Sudan grass") exhibit a type of damage entirely different from this and previous Groups (I - V).

In the groups given below, it was impossible to give the full name of the sorghum variety which participated in the formation of the object of our investigation, though for some groups we can indicate to which type, i.e. sugar, broom or grain, of sorghum the mother forms belonged. This material was taken into the sowing of the nursery collection from a hybrid field which served as a living herbarium for testing the breeding value and comparison with other forms. Among the latter we were able to distinguish several groups.

Group VII. Hybrid forms (sorghum × Sudan grass). The mother forms are used as silo or green forage. The damages are localized almost evenly on both sides of the leaf nerve in the form of a solid brown area, transformed towards the periphery into a number of more or less large black-brown spots.

Group VIII. Sorghum × Sudan grass hybrids. Maternal forms belong to the grain type. Damages appear as large slightly oblate black spots infecting 80 - 95 per cent of the surface of the leaf blade.

Group IX. Sugar sorghum × Sudan grass hybrids. There is no spotting, as in previous groups, bacteriosis infecting almost the entire surface of the leaf blade. The most severe damages appear on the middle of the blade ; the principal leaf nerve is also damaged, a point not observed in other groups. The stems and spikes are also partly affected.

Group X. Leaves, stems and spikes are equally affected. Spots formed on the surface of the leaf as the result of bacterial activitiy take the form of concentric circles of red-brown colour, paler towards the periphery of the leaf. These damages occur more frequently on natural hybrids of sorghum × Sudan grass, the maternal forms of which belong to the broom sorghum. Plants of this group show a wide range in types of damage, which have not yet been finally classified.

The character of bacteriosis of Sudan grass just described may, to some extent, be used in initial stages of breeding work, but it must be borne in mind that the study of the nature of immunity to bacteria and the building up of resistant strains requires collective research by breeders who work with this crop.

The following conclusions may be made :

(1) Among Sudan grasses there are only a few (two) immune forms ; the origin of this immunity requires further investigation.

(2) Immunity and susceptibility to bacteriosis are not equally expressed in the different biotypes : some of them show a low susceptibility, approaching in part to complete immunity, while others are almost wholly (80-100 per cent) affected.

(3) The colour and size of spots are probably only the physiological response of damaged tissues of the plant to the agents on the one hand and on the other, the norm of reaction of racial composition of bacteria to the substratum. The character, direction and regularity of their distribution demonstrate the ways of penetration of the agents and the resistance of the damaged tissues, resulting in conditions favouring the development of bacteriosis.

(4) Mass bacterial infection of plants was more frequently observed in cold and wet years.

In closing, the author wishes to express his acknowledgment to E. E. Heschel, Head of the Phytopathological Department of the Ukrainian Institute of Breeding, for valuable assistance and revision during the preparation of this paper, and to M. Žučkova, Technician of Sudan grass brigade at the Department of Herbage Plants of this Institute, for her help in the collection of the herbarium.

DROUGHT RESISTANCE.

The U.S.S.R. Congress on Agricultural Physiology was held in Leningrad on February 8th to 13th, 1932. The proceedings of this Congress have not yet been published, but the present review has been prepared from some short reports and other articles which have been published in recent numbers of various series of *Tr. Prikl. Bot. Genet. i. Selekcii*. The Congress was divided into the following sections :

(1) Planning of physiological research in U.S.S.R. (S. M. Ivanov).
(2) Regulation of plant development (N. A. Maksimov).
(3) Resistance of agricultural plants to : (a) winter and spring killing (I. I. Tumanov), (b) drought (I. V. Krasovskaja), and (c) saline soils (B. A. Keller).
(4) Plant nutrition : (a) mineral nutrition (O. A. Walter and S. P. Kravkov) and (b) photosynthesis (V. N. Ljubimenko).
(5) Standardization of education in agricultural physiology (V. S. Sokolov).

The present review and comments are concerned only with the problem of drought control to which subject a morning was devoted, when I. V. Krasovskaja delivered her opening address on " Synopsis and prospects of the problem of drought control." Krasovskaja first emphasized the urgent need for enlisting plant physiology in the solution of relevant problems, for agronomical treatments alone cannot detect in the complex interrelation of plants and their environment the significance of those factors which control the size of crops. The principal problems of plant physiology consist in general of (1) evolving methods for determining the degree of xerophytism in plants which will enable plant breeders to evaluate existing varieties in an easy and accurate manner, (2) evolving methods of increasing drought resistance in plants, and (3) evolving new and improving old methods of controlling drought.

It is important that by xerophytism should be understood the ability of plants not only to survive under prolonged drought, but also to produce the highest possible crop under these conditions.

The study of the problem is considerably complicated by the diversity of the types of drought (atmospheric, edaphic and their various combinations), and by the varying manner in which plants can resist the adverse effects of drought. It would, therefore, be incorrect to endeavour to establish any general characters of xerophytism or any general methods of controlling drought ; as Zelenskiĭ and Keller have shown, every plant or even variety must be studied as to its own particular requirements or behaviour. Krasovskaja emphasized that in periods of drought, one of the contradictions of plant life is manifested, namely, between the process of assimilating carbohydrates, for which a close intercourse with the air is required, and on the other hand the attempts of a plant to prevent an excessive loss of water, for which purpose isolation from the surrounding atmosphere is necessary. There are two principal ways in which plants overcome this difficulty, i.e. either through an adaptation which will ensure water supply, or through the ability to survive throughout more or less prolonged dry periods without serious damage to or loss of their crop. There are, of course, a number of intermediate forms between these two types. Hence the study of these characters and their significance for various types of plants under various types of drought is one of the principal trends of agricultural physiology.

Although the study of problems relating to drought has been proceeding for some considerable time, the investigation of various types of drought under concrete examples of xerophytism is of recent origin. In particular little is known regarding atmospheric drought ; T. A. Krasnoseljskaja-Maksimova has recently commenced to study the effects of dry winds by means of special chambers where

plants are subjected to the influence of a current of air which has been previously dried and heated. The effect of high temperatures, however, has not yet been investigated.

Owing to the great complexity of the problems leading to the breeding of xerophilous plants, it is of special importance to evolve simple and yet reliable methods of determining drought resistance, as without this aid a strict quantitative estimate of plants cannot be undertaken.

Recent research has, to a great extent, contradicted the widespread opinion that a low transpiration rate is an essential feature of xerophytism. This view had a marked influence upon the trend of breeding work where attempts were made to reduce transpiration by means of various morphological and anatomical characters. Research carried out by N. A. Maksimov with collaborators showed that there exist many xerophytic plants whose transpiration rate is very high and that all attention should not be concentrated on the transpiration coefficient. The faculty of surviving prolonged dry periods proved to be of greater importance.

Among existing methods only those which concern a direct testing of a plant as a whole deserve notice. In the first place there was the "wilting" method evolved by I. I. Tumanov based upon the fact that xerophytism is closely associated with the ability of a plant to survive a waterless period. The method consists in the subjection of plants at a certain stage to a prolonged wilting after which they are given a chance to recover and the degree of damage caused during wilting is recorded. This method, although simple in theory, proved to be not so simple in practice. Among the modifications which are specially promising is the testing of plants not in pots but in soil in so-called "Zasušniki" (drying houses), in which, by means of special screens, rainfall can be entirely excluded for a considerable period. Such houses, first constructed by A. A. Sapegin and later modified by I. V. Krasovskaja, are now widely used in the Soviet Union. By means of the "wilting" method in all its modifications only the resistance of plants to edaphic drought may be investigated. The influence of atmospheric drought, particularly in the formation of dry wind, has received very little attention until recently. The study of the physiological effect of fog associated with atmospheric drought, which was successfully begun by V. P. Zelenskiĭ, was left incomplete owing to the premature death of the investigator.

A considerable step forward in the study of atmospheric drought was made only through the work of Krasnoseljskaja-Maksimova already mentioned. In addition to providing a basis for an easy and precise method of evaluating plants under the effects of dry winds, it was discovered that the stage of development at which the plant is subjected to the effect of drought is of profound importance. [The second contribution on the results of this experimental study of dry winds has just been published by Krasnoseljskaja-Maksimova in collaboration with I. N. Kondo (Bull. Appl. Bot. Leningrad. Ser. 3 (5). 191-215. 1933), but that paper has not been included in the scope of the present review.]

On the whole it should be borne in mind that, although correct in their methodological approach, these methods are far from being complete. A tendency to find one single character which will provide the key to a general method of determining xerophytism, without considering a complicated interrelation between various aspects of plant life and environmental conditions, is essentially erroneous. This does not, of course, exclude the need for studying individual characters, for through them a convenient method of mass estimation of plants may be found. Determination of xerophytism in drying houses or by the "wilting" method is too complicated and too slow for the purpose, and thus attempts are constantly being made to find any incidental character through which an easy and quick estimation of the drought resistance of various plants may be made. Kolkunov suggested some considerable time ago the relative magnitude of contracting stomata as an indicator, but this did not receive universal recognition. Recent attempts of interest include that of

Vasiljev to correlate drought resistance in wheat with the dynamics of the daily changes of stomata, and that by Litvinov to correlate it with water content in leaves. These attempts can characterize xerophytism only within a narrow group of plants, and cannot, of course, replace methods of direct testing.

The collaboration of agricultural physiology in modifying agronomical methods and means of controlling drought is of no less importance, for until recently little attention has been given to the requirements of plants themselves: meanwhile the existing methods would be made considerably more effective if at the same time the physiology of plants subjected to new and environmental conditions created by agronomical means was investigated, in order to determine the water requirement at the critical period.

Owing to the diversity of the types of drought and the protective mechanism of the plants, it is necessary, in the speaker's opinion, to pass from a general abstract study of xerophytism and drought to a more concrete study of types of drought and the nature of xerophytism. In particular, greater attention should be devoted to increasing the xerophytic ability of the plants by means of the "wilting" method. Simultaneous with the study of xerophytism under natural conditions, it is also necessary to create conditions favourable for controlling all the elements of drought, i.e. to create in laboratories an artificial climate. Finally the speaker stated the need of passing from isolated research of physiologists to a correlated collective study of drought from all possible aspects.

Krasovskaja's report provoked considerable discussion and comment by the members of the Congress.

Thus, Petrov pointed out that by using the same amount of water, but by irrigating at different times, it is possible to improve considerably the yield of cotton and lucerne, but the physiological investigations of this phenomenon had not received the required attention.

Richter and Ničiporovič pointed out the need for a thorough study of resistance to high temperatures and thermic balance in agricultural plants. In arid zones plants absorb such a great amount of solar energy that to prevent over-heating of leaves they have to circulate a considerable amount of water; hence, the ability of plants to balance the solar energy received may be an important character of xerophytism. Another index of drought resistance may be the process of assimilation under definite combinations of temperature and water supply.

Sabinin indicated that the physiological study of xerophytism was not conclusively reviewed in Krasovskaja's report. Thus, the problem of colloidal changes associated with the effect of drought on plants was not mentioned; also problems such as methods of irrigating or of producing artificial rain by means of special outfits did not receive the attention they deserved in the report.

RESEARCH IN THE EXTREME NORTH.

The aim of this work is not an increase in the general productivity of the region, but the extension of agriculture, in particular dairy and vegetable farming, into new regions. One of the principal problems is therefore the supply of fodder for the dairy farms. The common representatives of herbage and silage plants are almost entirely absent in the indigenous flora and the principal concern of agricultural research in the far North is the discovery and introduction into cultivation of plants suited to the extreme climatic conditions. After a preliminary attempt in 1922, the systematic experimental study of the agricultural resources was begun in 1923. There now exist numerous experiment farms which are carrying on valuable research under the direction of the U.S.S.R. Institute of Plant Industry at Leningrad.

Some results have already been published in various agricultural journals of the Union and the Institute has therefore decided to commence a series of publications

under the title " Problemy Severnogo Rastenievodstva " (Problems of Northern Plant Industry). So far the following issues have appeared :

Part 1 containing articles on the general problems and trend of agriculture and research in the extreme North.

Parts 2 and 3 contain brief reports of the following farms : Hibiny Experiment Farm (later Station) for 1923-30 ; Kola Experiment Farm, 1923-30 ; Louh Experiment Farm, 1925-26 ; Obdorsk Experiment Farm, 1928-31 ; Ken Marshland Farm, 1930.

Experimental work with herbage and silage plants has progressed so far that a beginning has now been made with the reproduction of the most valuable ecotypes of *Phleum pratense, Festuca pratensis, Alopecurus pratensis* and with selection from the indigenous flora of forms of *Agrostis, Poa* and late and red fescues. Among annuals, in addition to rye and oats, forms of *Phalaris* from Switzerland and Africa (300 Dz. per ha.) and Italian ryegrass (490 Dz. per ha.) deserve special notice ; also among silage plants, forage cabbage and pea, and among roots local varieties of turnips are mentioned. Sunflower, mustard and sweet clover were not successful and are no longer being tested. Considerable attention was devoted to the study of types of marshes, their drainage and reclamation. Part 4 will be devoted to a review of arctic agricultural plants and Part 5 to results obtained in similar studies outside the Soviet Union. In future, in addition to occasional and serial publications on the subject, the Institute of Plant Industry will issue a special work entitled ' *Severnoe Rastenievodstvo* ' (Northern Plant Industry), devoted to a review of all the data on the ecological conditions of the extreme North and the results of relevant experimental research both within and outside of the Soviet Union.

HIBINY EXPERIMENT STATION.

This Station began work in 1931 (formerly Experiment Farm) as a Department of the U.S.S.R. Institute of Plant Industry, Leningrad, for co-ordinating agricultural research in the far North of the Soviet Union. A brief summary of the work at Hibiny (67°N. lat., 30°E. long.) during the period 1923-33 is given by the pioneer of agricultural research under these inclement conditions. [Eichfeld, I. G. Struggle for the Extreme North. Publication 47, U.S.S.R. Institute of Plant Industry, Leningrad, 1933, pp. 45.] Professor Vavilov states in the introduction that it is a record " of a great exploit of Soviet science."

The Station is divided into the following sections :

(1) Section of Plant Resources (I. G. Eichfeld, I. A. Veselovskiĭ and B. Ja. Bykovskiĭ) which is in charge of investigation, selection and seed growing (mostly under pre-sowing treatment) of suitable forms of agricultural plants.

(2) Section of Plant Physiology (V. I. Razumov and N. I. Smirnov) which deals not only with problems of local interest, but is primarily engaged in more general physiological research, in particular the study of thermic and photoperiodic factors and vernalization, which is becoming of increasing importance owing to the special environmental conditions (for July-September the thermic sum=1135°C. and the duration of daylight is almost 24 hours).

(3) Section of Agronomy (P. E. Efimov) is concerned with general agricultural and forage problems, and in addition with the problems of ozimizacii (hibernization) and jarovizacii (vernalization) of agricultural plants.

[It is hoped to be able to give further details of these studies in a future issue of *Herbage Reviews*.]

RECENT SOVIET PUBLICATIONS.

La Turquie agricole. (Partie Asiatique—Anatolie). [**Agriculture in Turkey. (Asiatic region—Anatolia).**] By P. Zhukovsky. [Russian text. Summary in French, pp. 775-908.] Moscow, Leningrad, 1933. 28×21. pp. 935. chromopls. map.

This publication represents one of the largest contributions yet produced by the Institute of Plant Industry resulting from one of the numerous expeditions which have been made to various parts of the world in search of new varietal material of cultivated plants. It is natural that the Soviet scientists should display a particular interest in their neighbouring countries, and from the material collected by P. Zhukovsky in Turkey it is evident that the Institute has had ample recompense for its efforts.

According to the preface by L. Karakhan, "the work of Professor Zhukovsky constitutes the first important product of the scientific contact between the Soviet Union and Turkey. This book, which represents the result of several years of work and scientific expeditions in Turkey, is important from three points of view: (1) It is of great scientific value as a contribution to the world literature of cultivated plants and as one of the rare truly scientific studies on Turkey, accomplished moreover by a Soviet scientist. (2) It presents considerable practical importance from the point of view of selection and the improvement of cultivated plants in Turkey which can result in a raising of the general level of Turkish agriculture. This is of great importance as agriculture still plays a preponderant role in Turkey. (3) The work of Professor Zhukovsky should contribute very considerably to the strengthening of the scientific links between U.S.S.R. and Turkey. In the present case the scientific contact between the two countries acquires a particular importance creating many possibilities for the exchange of experience and of fundamental study of conditions of plant growth and the further cultivation under similar climatic and soil conditions in the two countries. From this report, Turkey as well as U.S.S.R. can obtain appreciable advantages from their mutual collaboration."

The publication contains results of three consecutive expeditions in Anatolia carried out from 1925-27 and organized by the Institute of Plant Industry. The suggestion came from N. Vavilov while Professor Zhukovsky was Director of the Botanical Garden at Tiflis. The expedition in Anatolia was considered to be an indispensable link in the series of expeditions undertaken by the Institute with a view to the collection and study of cultivated plants in countries with an ancient agriculture. The essential aim of these expenditions was to create in U.S.S.R. a very extensive phytogeographical and genotypical collection embracing all cultivated plants as an initial basis for improvement as well as for direct introduction into agriculture. Another fundamental part of the programme of the Anatolia expedition was the study of the particularities of Turkish agriculture and of the varietal composition of its cultures.

The expedition has brought with it into U.S.S.R. an enormous collection of cereals, legumes, industrial plants and forage grasses and legumes. The total number of samples exceeding 10,000. From its practical results this expedition occupies one of the first places amongst those of the Institute of Plant Industry. The theoretical conclusions to which it has led are not less important. " In the light of the facts established, *Anatolia appears to be the cradle of the most precious European selected varieties.* The improved type of tender spring wheat, in particular the Squarehead, the improved type of grain legumes, the best commercial type of sesame, the vegetable carrot, the cultivated aniseed, cantaloups and cassava, the cucumbers

of Mourom, European lucerne (French), the type of poppy with a high content of morphine, a series of fruit cultures, wine producing grapes—these have been found in Anatolia and have passed from there into Europe. Anatolia, which is like a filter placed at the junction of three continents of the Old World, has therefore transmitted to Europe the improved type of whole series of cultivated plants."

" We think that for Turkey itself the results of our expedition should constitute a practical and theoretical basis for the development of plant industry. The study of cultivated plants in Anatolia has shown that Turkey possesses thousands of original varieties of various cultivated plants. This varietal wealth, these polymorphic populations represent an enormous potentiality at the hands of the selector. In describing here these populations, we give to the Turkish selector the key to the knowledge of the inventorization of varieties, of the arrangement of different characters which are indispensable to them for the selection and creation of new improved varieties."

The author then notes that he has defined Anatolia (in 1925-27) as having an oasis type of agriculture and that no attempt has been made to bring under cultivation the semi-desert areas. It is certain, however, that in the future an important part of these lands can and should be brought into agriculture, and that the percentage of cultivated land (5 per cent of the territory according to the 1927 census) must be markedly increased.

" We cannot take it upon ourselves to undertake such a radical change in the character of Turkish agriculture, in particular the bringing under cultivation of the desert lands. This problem demands a special study. We can only observe that with us in U.S.S.R. the conquest of the desert has made great progress—it is true under different social conditions than those of Turkey. We are on the highroad towards the attaining of the ' To-morrow' of which Lenin spoke when he remarked that ' in our days technique develops with unbelievable rapidity—and the lands unsuitable for cultivation to-day can be transformed into cultivated lands to-morrow.' "

Rapid changes have taken place since this observation was made. New cultures are appearing (plantations of tea, etc), a series of stations and selection Institutes have been created and the first pan-Turk congress of plant breeders has been held.

After these preliminary remarks, taken from the preface and introduction, the account proper commences. Considerable attention is devoted in the general part to relief, climatic provinces, general character of the vegetation and characteristics of the agriculture, before the special part on the various crops begins. Cereals, grain and fodder legumes, oil and essential oil plants, cotton, opium poppy, tobacco, cucurbits, vegetables and fruits are all dealt with at length.

The grain legumes include *Cicer arietinum*, *Lens esculenta*, *Vicia* spp., *Phaseolus*, *Pisum* spp., *Lathyrus*, *Vigna* and *Lupinus*.

The chief forage legume is lucerne, " which occupies an area of about 35,000 ha. in Anatolia. The principal region of cultivation is in the vilayets of the centre and of the east, although it is also much sown in certain vilayets of Western Anatolia. The seed production of lucerne is concentrated above all in the vilayet of Kayseri. In the wild state *Medicago sativa* covers vast areas in Eastern Anatolia and constitutes an important basis for improvement."

The author gives a botanical description of the Anatolian lucerne, noting particularly that it presents characters of gigantism, that the autumnal rosette becomes

modified as one passes eastward, according to the ecological conditions, and that a peculiarity of this type of lucerne is a very low percentage of hard seeds, which ensures a regular development after sowing. Sown in spaced drills, Anatolian lucerne gives the highest yields of all types and supplies a palatable hay.

The work of L. Bordakov has established the existence of two centres for the formation of races of *Medicago sativa*. One is in Tadjikistan where at high altitudes grow populations of wild lucerne which have given rise to the lucernes of Afghanistan and Turkmenistan. The leaf type of these lucernes can be seen in the lucernes of Persia, Syria and Europe. The other centre is situated in the high mountain region of Eastern Anatolia and these Anatolian races have similarly participated in the formation of the European types of lucerne.

Other species of lucerne which occur in Anatolia are listed, together with species of *Trigonella*, *Onobrychis*, *Trifolium* and *Melilotus*. The section on Leguminosae concludes with ten observations on the exceptional diversity and wealth of cultural varieties which are presented by the grain and forage legumes in Anatolia.

The final passages of the book deal with the general tendencies of Turkish policy in the domain of plant industry, the problem of the study of the country and the introduction of new cultures; conclusions are made regarding (1) the general characteristics of cultivated and wild plants used in Anatolia, as initial material for selection, (2) the geographical and genotypical peculiarities of cultivated plants of Anatolia, and (3) the general geographical concept.

"The selector, geneticist and agricultural botanist can draw practical and theoretical conclusions from our work. The plant resources of Anatolia should be made the object of particular attention."

Geobotanic Map of Kazakstan. [Reviewed by] A. V. Prozorovskiĭ in *Sovetskaja Botanika*. 5. 143-4. Leningrad, 1933.

During 1932-33 a geobotanical map on a scale of 1 : 1,680,000 was prepared with comments and explanatory text, under the supervision of B. A. Keller, at the Botanical Institute of the Academy of Sciences, where revision and completion were carried out.

The following final subdivision of the flora was adopted: (a) Steppe Region; forest-steppe zone of *Stipa* and other herbs, zone of *Stipa* and *Festuca*; (b) Semi-desert Region; zones of northern and southern semi-deserts; (c) Desert Regions; zone of northern and southern deserts; (d) Mountain Regions; desert belt, belt of mountain semi-deserts, belt of mountain steppes, timber-tree and shrub-belt, belt of highland meadows and belt of eternal snow.

It was decided to include also a soil map of Kazakstan which had been compiled at an earlier date.

Flora of U.S.S.R. (Flora Unionis Rerumpublicarum Sovieticarum Socialisticarum). Vol. 1. Published by the Leningrad Academy of Science Institute of Botany. Edited by V. L. Komarov. 26 × 18. pp. 318. Map. Leningrad 1934.

The first volume of the twenty which shall compose this Flora has just been received. The work has been compiled under the guidance of V. L. Komarov, vice-President of the Academy, and is based upon the collection of 20,000 plants in the herbarium of the Institute.

In addition to Pteridophyta, Gymnosperms, etc. this first volume deals with the first orders of the Monocotyledones, from Typhaceae to Hydrocharitaceae.

Piant Industry in U.S.S.R. Publication of the Institute of Plant Industry, Leningrad, edited by N. I. Vavilov. Vol. 1. Part 1. 30 × 24. pp. 12+xv+379, with 8 coloured maps and 9 line charts.
Vol. 1. Part 2. pp. 674, with 4 coloured maps and 80 line charts. Published by SeljKolHozGiz, 1933.

This valuable book of reference, edited by Professor Vavilov and compiled by over a hundred Soviet research workers, has been divided into two volumes, each containing two parts. The first volume has been received recently at this Bureau.

In the first part of Vol. 1, the problems of general agriculture are dealt with. In addition to a critical review by A. Bondarenko and the editor's preface, it includes chapters on (1) specialization of agricultural regions as affected by climatic (G. T. Seljaninov) and soil (L. I. Prasolov) factors, (2) object and problems of agricultural improvement (A. N. Kostjakov), and (3) regional distribution of agricultural plants in U.S.S.R. (R. I. Abolin, E. V. Bunakov, N. V. Kovalev, V. P. Kuzjmin, M. G. Popov, N. N. Sapožnikov and P. M. Zukovskiĭ).

The second part is devoted to various crops, their varietal composition, regional distribution, importance and husbandry. It closes with a collective paper on weeds.

In the words of Bondarenko, this very considerable publication "represents a valuable contribution to scientific literature and the collection of material for the characterization of natural regions . . . with a view to a correctly planned distribution of crops and varieties." It is possible that some of the conclusions as to limits of crop distribution areas will have to be modified when the bearing of the phenomena of pre-treatment of seed is fully understood.

The various articles comprising the second part will be dealt with by this Bureau on a later occasion, in either *Abstracts* or *Reviews*.

CONFERENCES

WAGENINGEN, HOLLAND.

A special number of the Dutch journal, *Landbouwkundig Tijdschrift* (No. 551 of Vol. 45, 1933), is devoted to the papers which were given at meetings held at the Green Fodder Conference on 3rd to 4th July, 1933. The following are summaries of the papers read at this Conference, which was opened by Professor C. Broekema of the Institute for Plant Breeding, Wageningen :

MEER, v. d. De economische beteeknis van Groenvoederbouw. [The economic importance of forage crop production.] Suppl. pp. 619-27.

Even with the present low prices of concentrated food the cultivation of a considerable quantity of green fodder is necessary for rational feeding of cattle. The present cultivated crops cannot be increased to such an extent that sufficient quantities can be obtained. New crops or new methods have to be introduced and other protein-rich fodders have to be tested.

GROENEWOLT, J. K. Eenige in ons land nog weinig verbouwde groenvoedergewassen. [Some green fodder plants as yet seldom grown in Holland.] Suppl. pp. 628-43.

The results of experiments with different varieties, times of seeding and harvesting of maize were discussed and information given on cultivation. The varieties Blanc des Landes (early ripe), Pettender Goldflut (medium to late ripe) and Virginia (horse dent, a late ripe variety) gave the best results. The early ripening varieties have to be used when sowings are made after the 1st June. The best stage for harvesting is when the corn begins to harden. Chaffing before ensiling is recommended.

Sunflowers should not be cultivated as a main crop. Their trial as a second crop is considered advisable.

It is not considered that millet will be of any great value.

Marrow stem kale was the best of the fodder kale varieties tested. The crops should not be planted before the 1st July. It is a good stable fodder for early winter. The fact that all expectations were not quite realized is considered to be due to lack of experience.

TJALLEMA, H. T. Enkele groenvoedermengsels. [Some green fodder mixtures.] Suppl. pp. 644-51.

Protein-rich green fodder crops are of great interest to mixed farms on sandy soils. The best results were obtained with a mixture of rye and *Vicia villosa*, sown in the early autumn and harvested at end of May to early June, to be followed by maize. Experiments with quantity of seed, method of seeding, and time of harvesting were discussed.

Experiments have been made with a wheat-*Vicia villosa* mixture, *Vicia villosa* alone, Italian ryegrass and *Trifolium incarnatum*. Several mixtures of summer crops were tried. Good results were obtained with the mixture of horse beans and a blue-podded form of *Pisum arvense* as a second crop.

MEIJERS, P. G. Een en ander over de cultuur van lucerne. [Some observations on the cultivation of lucerne.] Suppl. pp. 651-60.

(1) Hungarian lucerne gave the best result during recent years.

(2) Clay soils poor in lime or sour sandy soils are not suitable for lucerne. Clay and light clay soils rich in lime are best.
(3) Drainage must be good.
(4) Good results from bacterial cultures under special conditions are mentioned.
(5) The soil should be clean and well dressed with, or rich in, potash and phosphates.
(6) Lucerne must be drilled alone, and not under oats, barley, etc. Drill width 12 inches, seed rate 25-30 kg. per ha.
(7) The best remedy against weeds is a heavy crop, ploughing and hoeing after ploughing ; harrowing must follow.
(8) The crop should be mown and not grazed. Three cuts per annum are usual with no cutting or grazing after the first half of September, as the lucerne must be 25 cm. in height before winter.
(9) Dry the hay on tripods.
(10) The lucerne ley treated in this way will have a duration of three to four years.

BAKHOVEN, H. G. A. L. Het gebruik van kuilvoer. [The use of silage.] Suppl. pp. 660-70.

The use of different kinds of silage for fodder was discussed and practical instructions given.

BROUWER, E. Voederwaarde van kuilvoer en invloed op melk en melkproducten. [Nutritive value of silage and effect upon milk and dairy produce.] Suppl. pp. 670-81.

Feeding value of two types of silage and influence on milk and milk products were dealt with. The difficulties of analysing the chemical composition and starch equivalent of silage were discussed. Figures for the composition of different kinds of silage were given. Other matters dealt with were the effect of the two types of silage on the colour of butter fat, the vitamin content, the calcium and phosphorus balance of the animals, and the taste and smell of milk and quality of cheese.

DAALEN, C. K. van. De beteekenis van de conserveering van groenvoeder met behulp van zuren. [The importance of the conservation of green fodder by means of acids.] Suppl. pp. 681-8.

A description was given of the losses caused by haymaking and in the making of ordinary silage and Völtz silage, as compared with the advantages of the A.I.V. method as published by Virtanen. The results of the A.I.V. method in several countries were discussed.

Although satisfaction has frequently been obtained, the losses appeared to be larger than Virtanen has claimed. The Defu and A.I.V. methods were compared and the speaker uttered a warning against making improvements on the A.I.V. method before full experience has been obtained.

* * * *

A discussion followed most of the lectures and the Meeting, which had been organized by the NaCoVo (The National Fodder Culture Commission), was brought to a conclusion by Mr. H. Ruiter, Member of Parliament.

* * * *

The following are the addresses of the persons who gave papers at this Conference :

Ir. W. C. v. d. Meer—Rijkslandouwconsulent at Hengelo.
Ir. J. K. Groenewolt—Assistant to Prof. C. Broekema.
Ir. H. T. Tjallema—Rijkslandbouwconsulent at Zwolle.
Ir. P. G. Meijers—Director, Rijkslandbouwproefstation voor den Akker- en Weidebouw at Groningen.

Ir. H. G. A. Leignes-Bakhoven—Rijksveeteeltconsulent at Leeuwarden.
Dr. E. Brouwer—Director, Rijkslandbouwproefstation at Hoorn.
Dr. C. K. van Daalen—Rijkslandbouwconsulent at Bilthoven.

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STOCKHOLM, SWEDEN.

The International Seed Testing Congress will meet in Stockholm from 3-7 July, 1934. Twenty addresses will be delivered ; the State Seed Testing Station will be visited and the extensive control plots inspected. Excursions have been arranged to Ultuna (including Skokloster and Hammarby), to Östergötland to inspect seed plots of red clover and alsike clover, and to Scania to visit the Swedish Seed Association and Weibullsholm Plant Breeding Station, also centres where rational seed production of root crops and meadow plants is practised.

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ZURICH, SWITZERLAND.

According to the preliminary programme of the 3rd Grassland Conference of the North and Central European Counties, the meetings will take place from July 18th to 28th, 1934, under the patronage of the Swiss Agricultural Society in co-operation with other Swiss agricultural corporations. The Chairman will be Dr. A. Volkart, Professor at the Federal Polytechnical School in Zürich. The Corresponding Bureau of the Conference is the Federal Experimental Station for Agriculture, Zürich-Oerlikon. Invitations have been sent to individuals who have been working on the scientific and practical problems which were within the scope of the first two conferences. [For an account of proceedings at the last Conference, see *Herb. Rev.* 1. 100-3. 1933.]

Scientific papers are to be presented in German, English or French, either in the form of invitation papers (45 min.) or of short communications (15 min.). The problems within the scope of the Conference are :

1. Biological observations on the development of pasture animals.
2. Problems of silage and hay-making.
3. Questions concerning the combined utilization of pasturage and meadows.
4. Liming problems.
5. Organic manuring on permanent pastures.
6. Methods of determining and estimating the composition of permanent meadows and pastures.
7. The composition and behaviour of clover-grass mixtures.
8. The influence of number and time of cuttings on the yield of alfalfa.
9. The rôle of white clover in the composition of permanent pastures.

It has been arranged that 40-50 lectures and short communications will be included on the programme, which will take place in four sections.

On Saturday, July 21st, the participants in the Conference commence the programme of excursions which continues until the following Saturday, and includes visits to alpine pastures, farms and cheese factories.

SPECIAL NOTICE

SECOND BULLETIN ON VERNALIZATION.

The Imperial Bureaux of Plant Genetics at Aberystwyth and Cambridge are contemplating the publication of a revised issue of their joint publication on "Vernalization, or Lyssenko's method for the pre-treatment of seed" [Bulletin No. 9 in the Herbage Publication Series, March, 1933.]

As it is desired to make this new issue as complete as possible, it is intended to include reference to research on this subject which is in progress in any other part of the world, outside the Soviet Union.

The Chief Officer would therefore welcome communications from research workers interested in this problem, giving particulars regarding the object of experiments, results, variations in technique, and notes regarding the possible application of the method under the conditions of the country concerned. These data will be used, with due acknowledgments, in the new Bulletin, unless the wish is expressed that they may not be used for publication.

Letters should be received at the Aberystwyth Bureau by mid-September. Any information which will contribute towards this interchange of scientific experience, through the medium of the Bureau, will be most sincerely welcomed.

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